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NRC RESEARCH NEWS

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The cover photo and the lower photo on page 11 show how a pencil-like laser beam was used to adjust the mirror system in the light absorption tube being built at NRC.

The adjustment was made after the two casings holding the mirror system had been installed. The 109 foot seamless steel tube was not in place.

The laser unit was placed behind one of the mirror casings and focused on the other mirror. The laser beam was reflected back and forth between the mirrors a total of 40 times for the adjustment operation.

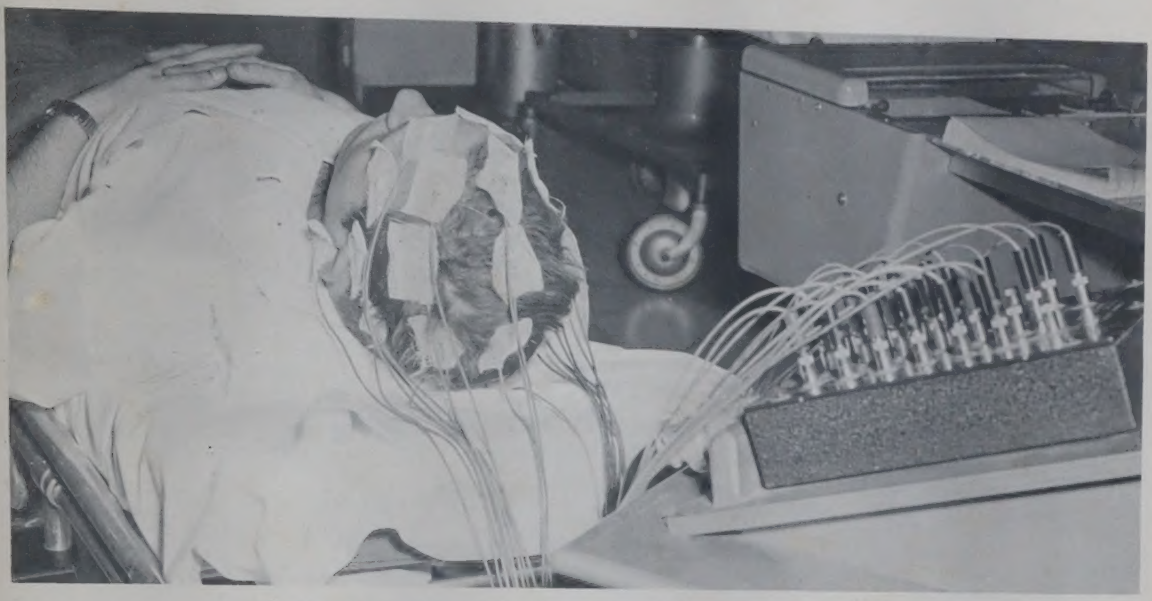
An ingenious photographic method was used to show the laser beams which are invisible. The laboratory was placed in total darkness and a camera with a time exposure of some seven minutes went into operation.

Photographer Lorne Bradley walked slowly between the two mirror casings spraying water vapour through the paths of the laser beams. The light picked up by the water droplets as they passed through the beams made the beams visible for the camera.

After Mr. Bradley had reached the second mirror casing, he left the camera's field of view. The overhead room lights were then flashed on briefly to illuminate the whole laboratory for the camera.

Photo Credits: Cover by Lorne Bradley of NRC; Found Aircraft by Found Brothers Aviation Limited; Memorial University and Dr. Aldrich by Memorial University of Newfoundland; Dr. A. M. Hunt by the University of Toronto; Dr. J. C. Polanyi by Jack Marshall & Co. Ltd., Cooksville, Ont.; others by NRC.

Listen to Brain Signals



A recent experiment in the study of human brain signals.

A Canadian scientific team has developed an instrument which enables doctors to listen to the complex electric signals produced by the human brain.

It is hoped that the instrument will lead to:

1. Faster diagnosis of brain disorders and abnormalities and the nature of brain injuries caused by accidents.

2. A method by which an electrode may be inserted deep inside the skull and located accurately in a particular brain structure.

The instrument, which employs the principle of frequency modulation, was developed by Dr. J. Alan Tanner and Mr. E. P. Edwards of the Control Systems Laboratory of the National Research Council's Division of Mechanical Engineering, and neurosurgeon Dr. E. W. Peterson of Ottawa.

The technique employed is an extension of the process known as electroencephalography (EEG) which, since the 1930's, has given doctors a visual recording of the activity of the brain. In this system, variations in the electrical potentials measured between electrodes placed on the scalp indicate the activity of the brain and are recorded on a continuously moving chart.

The new instrument enables doctors to listen to the brain signals with a set of earphones in much the same way as they listen to a heartbeat with a stethoscope. This means there is one less chart to watch.

The brain is composed of millions of nerve cells or neurons which discharge minute quantities of electricity. The time course of these discharges varies with different brain states. In an external examination, signals from the brain are picked up by electrodes fastened to the head of a patient. They are fed into the instrument which amplifies and converts them into sound patterns which can be recognized by the human ear.

Brain signals are low frequency phenomena which occur in the range zero to 30 cycles per second and are too low to be perceived by the human ear. However, by frequency modulating these signals they can be transformed to the range 500 to 1,500 cycles per second, so they can be heard.

Dr. Tanner and Dr. Peterson now are conducting a number of experiments to gain experience in distinguishing between normal and abnormal signals. They hope that this work will lead eventually to their being able to associate a particular brain signal with a particular abnormality, disorder or injury.

Research is also being conducted on the electrical activity occurring in the deep structures of the brain by inserting a probe deep into the skull. This research is being conducted on patients undergoing brain operations for the treatment of Parkinson's disease.

From this work may evolve a method for accurately locating a probe in a specific structure. The probe could be guided towards a trouble centre by means of sound patterns.

"This method of monitoring electrophysiological activity and the EEG in particular promises to find wide application," Dr. Tanner says.

New Utility Aircraft

Payload for Found Brothers aircraft (left); loaded and ready for takeoff (right).

A new Canadian aircraft, developed by a Canadian company with the assistance of the National Research Council, is expected to find a world-wide market as a utility freighter for bush country operation.

The single-engine aircraft, designed to carry payloads of just over 1,000 pounds, is the first light-weight freighter aircraft to be built in Canada since the Second World War.

Found Brothers Aviation Limited, of Rexdale, Ontario, developed the 3000 pound economy aircraft. The National Aeronautical Establishment of NRC proved out the structural integrity of the aircraft and recommended design modifications.

This reliable, rugged, no-frills freighter aircraft, which carries a price tag of $21,650, fills a major gap in the Canadian aircraft industry. Until its development, aircraft of this size had to be imported from the United States.

The aircraft is ideally suited for operation in rugged country such as the Canadian north. It has a short takeoff, steep climb, steep approach and short landing, a cruising speed of 129 miles an hour on floats and a range of 820 miles. Its Lycoming power plant develops 250 horsepower.

"The whole world has become a market for this type of aircraft," says N. K. Found, president of Found Brothers.

"Canada, continental U.S.A., Alaska, South America, Australia and New Zealand all have a need for sturdy economical air freighters. Our aircraft has no frills; it's designed to carry freight and does it well.

"So far all operators who have used it like it. The pilots like it, the mechanics like it and management likes it — they are making money with it."

The Found aircraft — known as the FBA-2C — is noticeably different from almost every other aircraft of similar configuration. It has no wing struts, used by aircraft designers to brace the wing and give it added strength.

Found Brothers decided to eliminate the need for wing struts since they are an obstruction to all loading operations. This was done by designing all the required wing strength into the wing structure itself.

NRC's National Aeronautical Establishment proved out the structural integrity of the wing. The Structures Section of NAE also conducted the required static tests on other sections of the airframe, strength of the engine mount and ground vibration and flight flutter tests.

"I can't speak too highly of the way NRC has helped us," Mr. Found says. "It wasn't only the technical assistance it gave — it was the confidence it showed in the ultimate national value of this enterprise."

F. R. Thurston, Director of NAE, says the aid given to the Found company is a typical example of the type of assistance which is made available to Canadian industry by NRC.

"NAE is happy to have been able to play a role in the development of this aircraft and the creation of a Canadian business operation that might otherwise not be in existence."

The Found plant now is capable of producing one aircraft every two weeks. So far 20 planes have been sold and an additional 15 are on the production line.

Besides being an economical freighter, the new aircraft will be valuable in evacuating injured or sick persons from remote areas of the Canadian north. Persons on stretchers can be lifted with ease into the cabin which is even big enough to accommodate dog teams.

Found Brothers aircraft equipped with floats.

Associate Awards Officer

Dr. Bernard A. Gingras, 39, a chemist with the National Research Council, has been appointed Associate Awards Officer of NRC's Awards and Committee Services branch. The appointment was effective January 1.

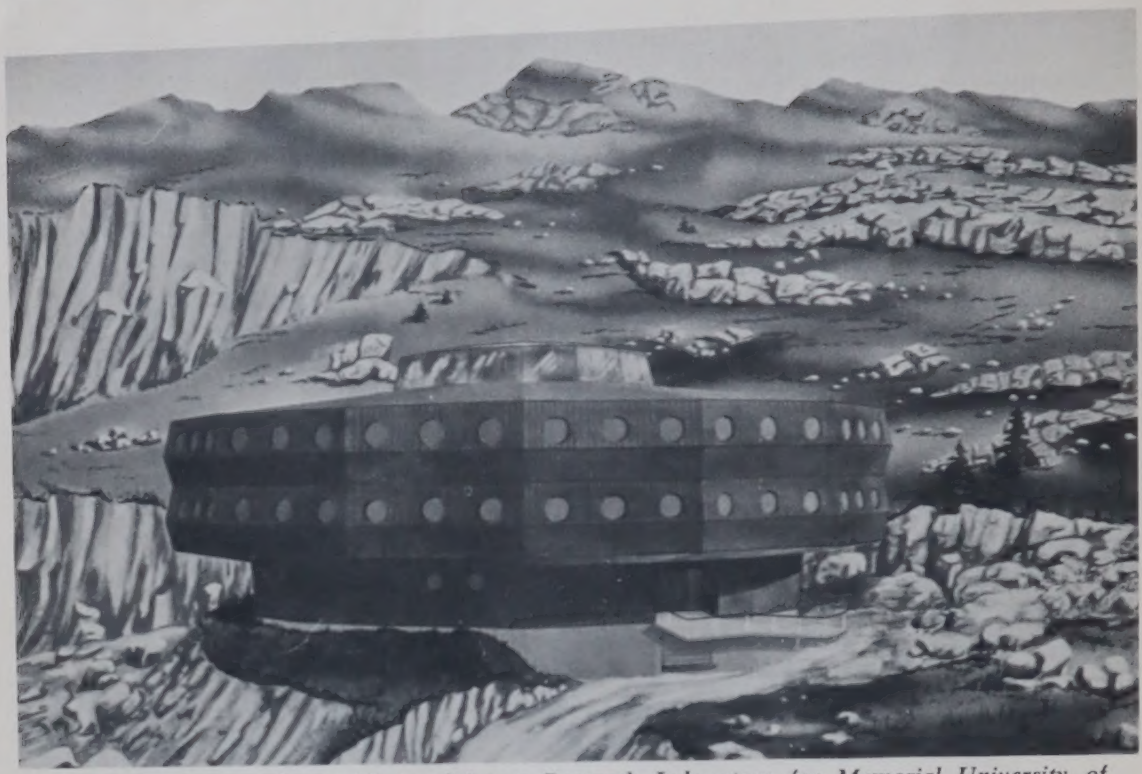
Dr. Gingras, who studied at Oxford University for two years after obtaining a doctorate in chemistry at the University of Montreal, will work with Dr. J. B. Marshall, NRC Awards Officer, in the administration of NRC's program of awards and scholarships to support research in Canadian universities. The value of this program in 1965-66 will amount to about $22,000,000.

A native of Montreal, Dr. Gingras was a member of the Textile Chemistry Section of NRC's Division of Applied Chemistry for 12 years. During that period he was involved in research programs in the fields of sugar chemistry, free radical chemistry, cellulose chemistry, co-ordination chemistry, and the study of chemical structure and mechanism of action of fungicides and non-ionic detergents.

Dr. Gingras graduated from the University of Montreal in 1948 with a B.Sc. He obtained his M.Sc. in 1949 and his Ph.D. in 1952, when he was awarded an NRC Postdoctorate Overseas Fellowship to study at Oxford University.

He studied at Oxford on this Fellowship for one year and for a second year on a Merck Postdoctorate Overseas Fellowship awarded through NRC. He received a Doctorate of Philosophy (D. Phil.) on the completion of his studies in September, 1954, and returned to Canada to join NRC.

Marine Research



Artist's conception of new Marine Sciences Research Laboratory for Memorial University of Newfoundland.

Memorial University of Newfoundland is building a Marine Sciences Research Laboratory to make possible a year-round study of the marine organisms of Newfoundland waters.

The National Research Council has made an initial grant of $300,000 to the University towards the cost of construction and will provide an annual operating grant. The provincial government of Newfoundland also made a generous contribution.

The new laboratory building, to be located at Logy Bay, some four miles north of St. John's, is expected to be in operation early in 1967. It will be situated about 100 yards from the ocean on the craggy Newfoundland coastline.

Newfoundland is in a unique geographical position surrounded by a subarctic, boreal ecosystem (northern aquatic life system) about which relatively little is known. In addition, the presence of Arctic and other drift ice in the area for certain months of the year offers possibilities for research not so easily open to other universities.

It is necessary for a marine laboratory of this nature to have an adequate supply of unpolluted seawater, thereby enabling experimental study of live marine organisms under controlled conditions. Such studies will involve numerous specimens of marine algae and higher plants, and vertebrate and invertebrate organisms. Functional morphology and physiological, as well as life history and behavioral studies are contemplated.

The seawater supply will be drawn from a man-made cave blasted out of the offshore rock face 30 feet below the surface and some 20 feet from the shoreline. Water in the cave will be fed to a storage tank for gravitation to the laboratory itself.

This seawater system will be of the most up-to-date design and will function 24 hours a day, 365 days of the year.

The new building will be circular, the lower floors containing service areas, supply and equipment rooms, and the two upper floors housing research laboratories. The dome will house botanical work. Architecturally, the building will be constructed of poured-in-place concrete, cantilevered from a central core. It will have no exposed steel of any kind. The finish of the building will be redwood with vertical battens. This will serve as a rain and sea spray screen to the structure itself.

Only the core walls are structural, or permanent, and all mechanical and plumbing equipment will be exposed for easy maintenance and alteration, depending on requirements.

The Director of the Marine Sciences Research Laboratory of Memorial University is

Dr. Frederick A. Aldrich, Professor of Biology at Memorial University. Dr. Aldrich has been on the staff of the University for five years, going to Memorial from the Academy of Natural Sciences of Philadelphia.

Dr. Aldrich was born in 1927 in Butler, New Jersey. After attending Drew University (A.B.) and Rutger's University (M.Sc., Ph.D.), he took specialized courses in aspects of Marine Biology at the Marine Biological Laboratory, Woods Hole, Massachusetts.

Dr. Aldrich brings a varied experience to the position of Director, having conducted research in numerous aspects of freshwater, estuarine and marine biology. For seven years prior to going to Memorial, he was on the staff of the Academy of Natural Sciences of Philadelphia where he was Curator in charge of the Division of Estuarine Science. His research activities have taken him to three continents, including participation in the Catherwood Foundation Expedition to the Peruvian Amazon.

His current research interests lie primarily in the squid of the Newfoundland coastal waters, including the so-called giant squid of the family Architeuthidae.

Dr. Frederick A. Aldrich

Steacie Memorial Fellowship

Dr. Mohsen Modarres Razavy, 31, Assistant Professor of Physics of the University of Alberta, Edmonton, has been awarded the E. W. R. Steacie Memorial Fellowship for 1966.

Established by the National Research Council in March, 1963, the Fellowship perpetuates the name of Dr. E. W. R. Steacie, President of the Council from 1952 to 1962.

Reflecting Dr. Steacie's outlook and principles, the award is designed to give outstanding and promising young staff members of Canadian universities the opportunity to spend two or three years in uninterrupted research.

The Fellowship is limited to research in the natural sciences and there is no restriction as to nationality or citizenship of candidates. It must be held in a Canadian university or affiliated research institute and will normally be held by a university staff member at his own university.

The Fellowship is to be held for a period of two years and may be renewed for an additional year.

Dr. Razavy, a native of Mashhad, Iran, is the second recipient of the E. W. R. Steacie Memorial Fellowship. It was first awarded in 1964 to Dr. Neil Bartlett, Associate Professor of Chemistry at the University of British Columbia.

Dr. Razavy received his Masters Degree in Mining Engineering at the University of Tehran in 1956, and his Ph.D in Physics at Louisiana State University in 1961. He joined the University of Alberta in September, 1962, as a Fellow with the Theoretical Physics Institute, and was appointed Assistant Professor of Physics in September, 1963.

During the period Dr. Razavy has been with the University of Alberta, he has shown a high degree of technical aptitude and fine creative imagination in the field of theoretical nuclear physics.

Strontium-90 Study

Dr. Hunt at work in his laboratory at the University of Toronto.

Some 30,000 teeth from children in five Canadian cities show that fallout strontium-90 has not been a health hazard to Canadians.

This is shown in a report prepared for the National Research Council's Associate Committee on Dental Research by Dr. A. M. Hunt, Professor of Dental Public Health at the University of Toronto.

Dr. Hunt's research showed that breast-fed babies appear to get about two-thirds as much strontium-90 as babies on bottles. However, in both cases the dose is so small as to be negligible.

The report says that teeth that formed in 1958 (one must wait five years until these baby teeth naturally fall out) in bottle fed babies contained not more than 2.2 to 3 picocuries of strontium-90 per gram of calcium. Breast fed babies received less.

A picocurie is one millionth of a millionth of a curie, a unit of measurement of the radioactivity of one gram of radium.

According to the United Nations Committee on Radiation, 68 picocuries would be safe in the human ("even here, there is a safety factor, and it may be that five times the UN 'safe' level would actually be quite safe," says Dr. Hunt).

To measure the amount of strontium-90 in teeth at all, Dr. Hunt had to measure from 20 to 70 teeth at a time.

"Even then, you can imagine the small amounts involved from the fact that a watch with a luminous dial might give 10,000 counts a minute whereas these teeth provided from one to two counts a minute," he says.

The research has been carried on for five years, supported by an annual NRC grant of $8,000. It is expected to run one year more.

"It took a long time to work out methods and to collect enough teeth," says Dr. Hunt.

An early problem was: is there a correlation between the amount of strontium-90 getting into teeth and the amount being assimilated by bone? It was the strontium-90 in bone that was most important, but this was difficult to study directly. If a correlation could be established between the relative uptake of teeth and bone, then teeth could be used as an index. They were relatively easy to study, being obtainable in the form of shed baby teeth.

Dr. Hunt carried out extensive tests in calves, examining both teeth and bones. He found there was indeed a correlation. He studied groups of calves killed respectively in January, 1963, September 1963, and September, 1964, with 11 calves in each group.

The Russians carried out extensive atom bomb testing in 1961 and fallout rose steadily, reaching a peak in 1964. Tooth content of strontium-90 rose by 600% in cattle, reaching a top level of 60 picocuries. Strontium-90 content in bone was higher than in teeth in periods of declining fallout and lower than teeth in

periods of rising fallout.

"Cattle, of course, always get much more fallout than humans because they eat grass which has been contaminated directly. Amounts of strontium-90 in milk are much lower than they are in the cow's bone or teeth," says Dr. Hunt.

If human bone has less strontium-90 than human teeth, then human babies must have received negligible doses, he says, "and I think the principal thing to say about this study is that it should reassure people that no danger exists."

About 10,000 baby teeth were collected each from Toronto and Montreal, and a further 10,000 from Hamilton, Vancouver and Calgary combined. These showed that Calgary received the highest dose of fallout, with Vancouver, Montreal, Toronto and Hamilton following in that order. These results confirm findings from the analyses of milk carried out by other researchers at the Department of National Health and Welfare.

Collection of the teeth was started by Mrs. E. Kesler in Montreal, and the Voice of Women and members of the dental profession extended it to other cities. The Varsity Fund and several industries provided supplementary funds to those of NRC.

"Generally speaking, rainfall and latitude are important in deciding where the heavier fallouts will occur," Dr. Hunt says.

The study was by no means easy to carry out. It was, says Dr. Hunt, "tedious". First the strontium had to be extracted from the teeth by a nitric acid separation process.

Teeth have large amounts of calcium which is similar in metabolism to strontium (which is why strontium-90 is taken up by teeth). The calcium is removed from the teeth by dissolving the whole tooth in nitric acid.

There is a small difference in the solubility of calcium and strontium. By adding a little non-radioactive strontium it becomes possible to remove and measure the strontium-90. All this requires 35 chemical steps.

"It takes about a week to prepare eight samples," says Dr. Hunt. "I've prepared more than 500 samples of human material and six to seven hundred of cattle."

One of the difficult problems in deciding exact uptake rates from bone samples is, of course, that the turnover of bone varies greatly with age. In infants up to a year old there may be as much as 50% to 100% replacement of the bone that was present at birth. But in adolescents and adults this may fall to a replacement of two to eight per cent of bone a year.

NRC PIER Fellowship

The National Research Council has expanded its awards program to assist engineers and scientists from industry to acquire research experience in university or government laboratories.

The Council has announced the establishment of a Post-Industrial-Experience Research Fellowship to be known as the PIER Fellowship. For a trial period of two years, a maximum of 15 Fellowships, carrying with them an annual remuneration of $6,000 each, will be awarded each year.

The aim is to provide a year of research experience in university or government laboratories, for engineers and scientists who have had professional experience in industry. Awards are for one year only, with acquisition of research experience as the prime objective.

Applicants for the Fellowships must have a minimum of a Master's degree from a recognized university and a minimum of two years' industrial experience, involving the candidate's scientific knowledge.

The Fellowship will be tenable in science and engineering departments of Canadian universities or government laboratories. Fellows are expected to undertake research programs compatible with the program and research interests of the institution at which the Fellowship is held.

The deadline date for receipt of applications for Fellowships in 1966-67 is May 1. Application forms and additional information may be obtained from The Awards Officer, National Research Council, Ottawa 7.

New Research Tool at NRC

Dr. Ramsay and Mr. Goetz are shown lining up a spectrograph.

The National Research Council is building a versatile and highly sophisticated tool for an expanded program of research into the structure of molecules and the nature of chemical reactions.

The tool is a massive light absorption tube designed by the Larger Molecule Section of NRC's Division of Pure Physics. It will be in operation in about a year.

The tube will be an additional facility to enable scientists to determine more accurately the structures of materials in a gaseous state. It also will help them to learn more about chemical reactions.

"We will be looking into the unknown," says Dr. D. A. Ramsay, head of the section.

"This is fundamental research. However, knowledge gained by this type of research leads to applied research. The transistor was the result of fundamental research on metals at low temperatures."

Dr. Ramsay's section will be observing the absorption spectra of chemical compounds by means of a powerful beam of light.

Increased knowledge about the structures of molecules obtained in this way could lead to the creation of new chemical compounds and perhaps new products.

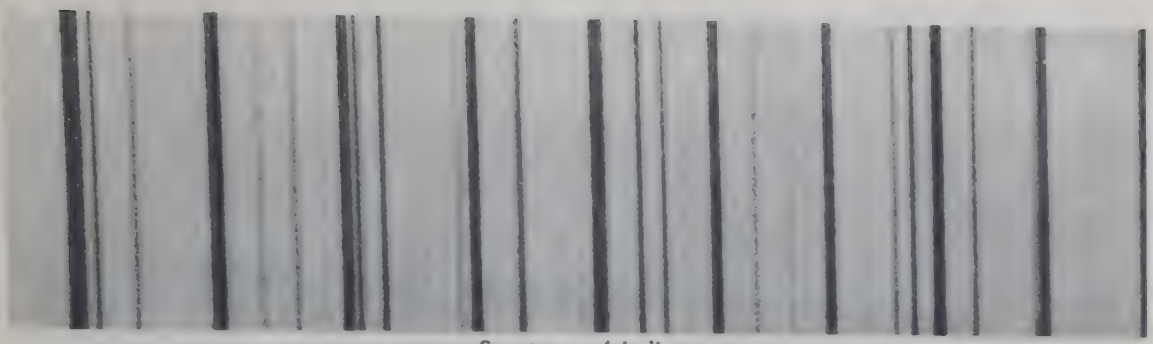
The absorption tube will consist of a seamless steel tube 109 feet in length and 16 inches in diameter with a multiple reflection mirror system at both ends. When it is in operation, it will be filled with a gas. Light from a powerful arc lamp then will be beamed into the tube.

The mirrors are designed to obtain the maximum effect from one beam of light exciting the gas molecules. These mirrors can be so finely adjusted that the beam of light can be reflected back and forth through the tube along different paths as many as 100 to 200 times. This means that the light source has travelled a distance of from two to four miles.

The mirror casings and the steel tube will be mounted on pedestals built on bedrock. This will reduce vibration of the structure to a minimum and keep the light source on a steady course as it travels back and forth between the mirrors.

It also will be possible to place gases being studied in the tube under pressure. This will greatly increase the effect of the light on these more tightly packed molecules.

As the light travels back and forth along the tube, some of its wavelengths will be absorbed by the gas molecules being studied. After the light has completed its trip, it will travel out of the tube into a spectrograph, where the remaining wavelengths of the light beam will appear



Spectrum of iodine.

as a spectrum and will be photographed.

These photographs will show the wavelengths which were not absorbed by the molecules inside the tube. Dark lines on the photographs represent those wavelengths which were absorbed.

If a gas, such as ethylene, is in the tube in an excited state, its molecules will absorb some of the wavelengths of the light in the tube.

The change in the structure of the ethylene molecule as a result of excitation by light absorption can be determined by examining its spectrum. Each change in the structure of the molecule brought about by light absorption can be determined because no two substances have the same spectrum.

With this type of information, NRC scientists hope to expand man's knowledge of the structure of molecules and the nature of chemical reactions.

The section also is building a special spectrograph for use with the absorption tube. Until it is ready, in about a year, the section's existing spectrographs will be used.

A laser beam was used by Werner Goetz, a senior technician with Dr. Ramsay's section, to adjust the mirror system. It was ideally suited for this purpose because of its extremely stable beam properties.

Another view of the use of a laser beam to adjust the mirror system in the light absorption tube. *See page 2.*

Crash Position Indicator

"AIRCRAFT LOCATED, SURVIVORS PICKED UP BY CHARTER CIVIL AIRCRAFT AND EVACUATED TO HAY RIVER."

That terse radio message ended a two-day search for a missing aircraft in the Canadian North and proved for the first time that a National Research Council invention saves lives.

The invention is the NRC-developed Crash Position Indicator. It consists of a crash activated aerodynamic recovery system, which is automatically ejected from the fuselage of an aircraft in the event of a crash. It delivers to safety a radio distress beacon payload, and keeps it on the surface of land or sea where it is oriented to send out a distress signal as far as 80 miles for many days to allow search aircraft to home in to its location.

On November 21, 1965, a Beaver aircraft with a pilot and a passenger aboard took off from Fort Simpson in the Northwest Territories on a flight to Nahanni Butte, and thence to Hay River and Fort Smith.

About one hour and 48 minutes after takeoff, the Beaver ran into a blizzard in a desolate stretch of country near Great Slave Lake and crash landed. The temperature ranged from 10° above to 20° below zero.

RCAF search and rescue headquarters in Winnipeg were notified late on November 22 by the RCMP at Fort Simpson that the Beaver aircraft was missing.

On November 24, flying above cloud at 8,000 feet, an RCAF Albatross search and rescue plane picked up and homed in on distress signals from a SARAH (Search And Rescue and Homing) manually operated distress beacon and the C.P.I. automatic one. A second Albatross picked up only the C.P.I. beacon signal. Maximum ranges obtained with the SARAH were 24 miles and with the C.P.I. — 32 miles.

After the crash site had been pinpointed, a civilian aircraft from Hay River picked up the two survivors who were not injured in the crash.

The Crash Position Indicator was developed jointly by NRC's National Aeronautical Establishment and the Radio and Electrical Engineering Division. NAE developed the aerofoil crash recovery system, while REED and NAE jointly developed the beacon payload which will operate in Arctic weather for many days.

Harry Stevinson, an engineer with NAE's Flight Research Section, who directed the development of the aerofoil system, says that prior to last November 21, there had been

seven crashes by aircraft equipped with the Indicator. In all cases the C.P.I. system had detected the crash and operated properly, but an RCAF search had not been required because these crashes were near airports or were too gentle to smash the aircraft's own communication radio.

"The November 21 crash was an historic event in the development of the C.P.I.," he said. "It was the first time that the C.P.I. contributed to the finding of an aircraft which had disappeared."

The C.P.I. system was originally conceived to give aid when it is needed most — when injured survivors are lying helpless and cannot find or use a manually operated beacon like the SARAH even if it survives by good fortune.

SARAH has a life of about 17 hours in warm weather but can be strung out by operating a few hours a day when survivors are uninjured. The C.P.I. had run almost 66 hours continuously when picked up by search aircraft in this case. An area of 33,600 square miles was covered in 10 hours and 40 minutes by the electronic search aircraft.

The C.P.I. is being manufactured by Leigh Instruments Limited, of Carleton Place, Ontario, under a licence granted by Canadian Patents and Development Limited, a subsidiary of NRC.

Mr. Stevinson

1965 Steacie Prize

Prof. Neil Bartlett, (inset) 33, of the Department of Chemistry, University of British Columbia, and Prof. J. C. Polanyi, 36, of the Department of Chemistry, University of Toronto, will share the 1965 Steacie Prize.

The Prize consists of the income from the E. W. R. Steacie Memorial Fund to which colleagues and friends of the late President of the National Research Council contributed. It is awarded annually by the Trustees of the Fund for outstanding work done in the Natural Sciences by younger people.

Dr. Bartlett is cited for the preparation in October, 1962, of the first true compound of the rare gas xenon. By successfully combining xenon with another gas to form a stable chemical compound, a reaction previously regarded as impossible, he not only overthrew a number of existing theories on chemical bonding, but opened up a new field of scientific investigation.

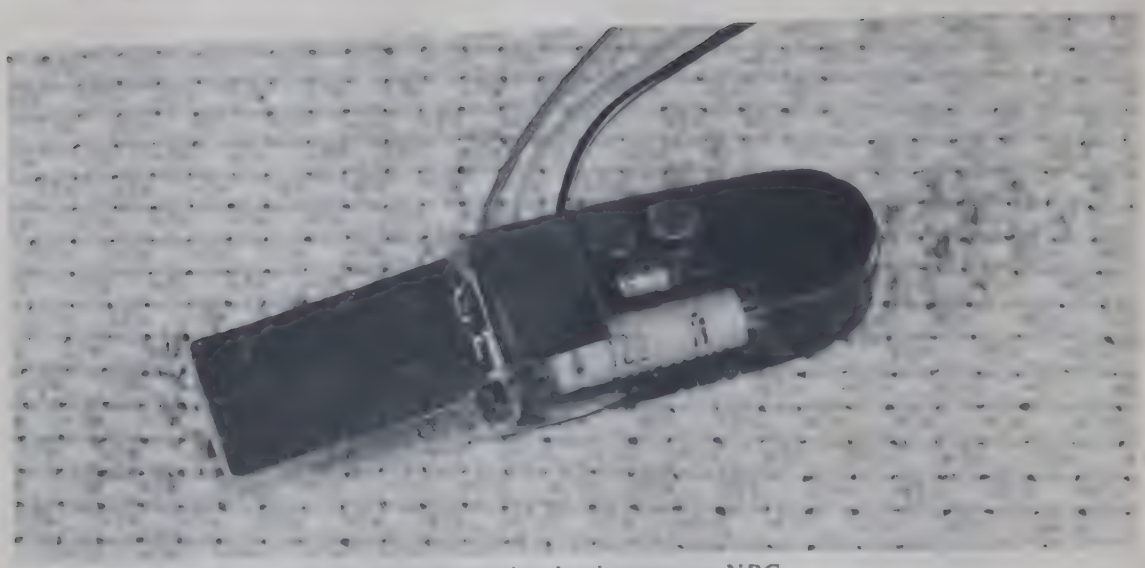
As a result of his work with xenon, the chemistry of the rare gases now is being studied in laboratories the world over.

Dr. Polanyi was the first scientist to observe infrared chemiluminescence — the emission of light brought about by chemical reaction. The experimental techniques that he evolved now have been refined and a wide range of atomic and molecular excitations caused by chemical reactions are being studied by scientists.

Five years ago, Dr. Polanyi also published a proposal for a chemical laser and it has recently been shown to be practical.

Dr. Barlett and Dr. Polanyi received the Prize at a dinner at the University of Toronto, January 24. The value of the 1965 Prize is $1,200, which will be shared by the two scientists.

Heart Pacer



Heart pacer under development at NRC.

Encouraging progress is being made by National Research Council scientists in their efforts to develop a pacer for damaged hearts that would be operated by electricity produced by the human body.

The research is rapidly reaching the stage where scientists believe that the stimulator and its power source can be implanted not only in the body but in the heart itself.

Pacers now in use consist of a number of mercury batteries and a transistor which are implanted in the abdomen. The beat of a damaged heart is stimulated by electrical impulses from the transistor, which are transmitted to this organ along two platinum wires imbedded in the heart muscle.

The pacer unit, which is about the size of a hockey puck, usually is adjusted to produce a heartbeat of about 70 a minute. This is sufficient to restore to near normal activity a person whose heartbeat has slowed to the point where the output of blood by the heart is not sufficient to maintain normal life.

The main drawback of this type of pacer is the relatively short life span of the batteries, which have a theoretical life of between three to five years. Patients face an operation each time the batteries must be replaced.

The Instrument Section of NRC's Radio and Electrical Engineering Division is engaged in a study in which the electrolytes in the body fluids are used as an integral part of an electric battery.

In experiments with animals, two dissimilar metals imbedded in the body replace the mercury batteries. Combinations of silver chloride and zinc, silver and zinc, and platinum black and zinc are being used.

Two small metal plates about one inch square are mounted on either side of the stimulator which is wired to the heart muscles. The device is about the size of a clothespin.

"By a galvanic process similar to that which takes place in a car battery, we are able to generate enough electricity to activate a pacer and stimulate the heart," says O. Z. Roy, an engineer with the instrument section.

"The electronic circuitry of these pacers is slightly more complex than the battery type now in use," he says. "The voltage that is developed by the body fluid battery is too low for proper long-term stimulation. As a result, an energy converter has to be incorporated which steps up the voltage to a level where enough energy can be transmitted to the heart to maintain pacing."

Mr. Roy says a great deal of work still has to be done optimizing the system, making it smaller, in finding the best sites for electrode implantation in the heart and in finding the most suitable metals.

However, in experiments to date, the device has been successful in stimulating the heartbeat of animals for long periods of time.

Mr. Roy says the results of the studies indicate that it is not inconceivable that the entire stimulator and power source can be implanted right in the heart. Such a pacer would be inserted directly into the heart through the jugular vein to the region of the heart's right ventricle apex.

Maple Leaf Flag

A co-operative effort by Canadian industry and the National Research Council has solved the problem of the fading red in Canada's Maple Leaf Flag.

A precise specification of a standard red shade for the flag now has been evolved by the Radiation Optics Section of NRC's Division of Applied Physics.

"Flags manufactured to this specification no longer will fade significantly during the life span of the flag material," says Dr. Gunter Wyszecki, head of the section.

NRC was asked last June by the Prime Minister's Office to specify the red that should be used in the flag. Dr. Wyszecki undertook the research project with the co-operation of flag manufacturers, textile mills, dyemakers and printers, and completed the work last November.

Dr. Wyszecki was assisted by the Textile Chemistry Section of NRC's Division of Applied Chemistry. Miss A. S. Tweedie of the section conducted laboratory fading tests on samples of red material supplied by industry.

The research project resulted in the selection of two samples of limit shades of red. The recommended red for the flag is between these two shades.

The two limit shades of red were chosen to give the flag manufacturer an indication of the acceptable tolerance of red shades.

In addition to the selection of material samples of limit shades of red, color coordinates have been determined to pinpoint the standard red shade in an objective manner.

Dr. Wyszecki says that direct consultation with Canadian dyestuff manufacturers and NRC laboratory tests shows that dyestuffs can be formulated in the desired red shade which exhibit an excellent degree of color fastness.

"This has enabled us to state that a Canadian flag can now be produced with a satisfactory balance of color fastness and wear life of the fabric. The recommended fabric is 1.9 ounce nylon taffeta."

Six test flags manufactured with essentially different dyes, and in most cases close to the standard shade, now have been flying on the roof of NRC's Applied Physics building for 4½ months.

"The red in these flags had faded very little," Dr. Wyszecki said. "Fading has not yet reached the stage where it is objectionable."

However, the flags are beginning to start to tatter after being exposed to most types of weather over the 4½ months. This shows that the color selected is outlasting the life of the material.

Maple Leaf Flags flying on the roof of NRC's Applied Physics building.

NRC RESEARCH NEWS

MARCH-APRIL, 1966

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SCHOLARSHIPS

The National Research Council has granted 1,705 scholarships for 1966-67, with a total value of $4,564,000. The number of scholarships granted represents an increase of 38.5 per cent compared with 1965-66, while the value is up by 42.6 per cent.

Of the 1,705 scholarships, 1,431 are for graduate work at Canadian universities. These include 505 bursaries worth $2,500 each and 926 studentships worth $3,000 each.

Awards for study outside Canada include 179 special scholarships worth $3,000 each, ($3,000 in U. S. funds if tenable in the United States). The awards are for Ph.D. studies in the U.S., United Kingdom, France, Australia, Belgium, Germany and Israel.

Ninety-five postdoctorate overseas fellowships, valued at $5,500 for married and $4,500 for single fellows, have been granted for work in 12 countries.

The Council also has awarded 24 NATO Science Scholarships and Fellowships for 1966-67, with a total value of $120,000. These awards, for study abroad in various fields of pure and applied science, are designed to stimulate the exchange of post-graduate students between member countries of NATO. They represent Canada's part in NATO's Science Fellowship Program.

Cover: NRC's airborne simulator. See page 10.

Photo Credits: Tilt Wing VTOL aircraft by Canadair Ltd., Montreal; Water bomber aircraft by B.C. Forest Service; aircraft conducting spraying operation by Canada Department of Agriculture; others by NRC.

Churchill Research Range Placed Under Control Of National Research Council

The Aurora Borealis Over Northern Canada

Is Being Studied With Black Brant 2A Rockets

Like This One Fired by NRC's W. L. Haney

"Five, four, three, two, one—FIRE—plus one, plus two—"

That count, the final stage of a rocket countdown, is heard almost daily at the Churchill Research Range at Fort Churchill, Manitoba.

The sprawling range has been the scene of an active program of research since it was placed under the direct control of the National Research Council on Dec. 31, 1965. Prior to that date it was operated by the United States Air Force's Office of Aerospace Research.

Radar site at Churchill Research Range.

NRC's new Space Research Facilities Branch, headed by Dr. R. S. Rettie, is managing the range for the joint benefit of Canadian and American scientists under joint Canadian-American funding. Range facilities also may be made available to scientists from other countries.

Most of the rocket research at the range involves studies of the Aurora Borealis (northern lights), which causes disturbances in radio and telegraphic communications, in efforts to obtain new knowledge of the outer reaches of the earth's atmosphere.

Within days after the turn-over, a busy schedule of sounding rocket firings was in progress under direction of Dr. J. H. Brandy, General Superintendent of the CRR. Dr. Brandy's staff of about 17 NRC employees supervises the operation of the range and provides range safety functions, while Pan American World Airways, with some 200 employees, carries out the actual operations on a contract basis.

The first rocket fired under NRC control on January 5, 1966, was an ARCAS Meteorological rocket, launched in support of the World Meteorological Rocket Network. It rose to an altitude of some 40 miles to record temperature, pressure and winds.

Similar information is gathered by other Arcas rockets launched regularly at some 20 points around the globe. Since Jan. 1, more than 25 of these six-foot long rockets have been fired from the Churchill range.

A peak of activity occured in February, 1966, when six rockets were fired within 15 hours, a record never approached before during normal operations, and only one hour longer than took place at the time of the Solar Eclipse of July 21, 1963, when five extra portable launchers were brought to Churchill for the occasion.

At the beginning of March, more than 70 scientists and technicians from various points in North America were at the range to take advantage of normally favorable weather and intense auroral activity. Each group brought independently designed scientific experiments, instrumentation and rockets.

During March two single stage, solid fuel, Black Brant 2A rockets were launched for NRC, with Alan Staniforth of the Space Electronics Section of the Radio and Electrical Engineering Division as Project Co-ordinator.

The firing key for the first of these was turned by W. L. Haney, Head of the Space Electronics Section, with E. E. Budzinski of the Cosmic Ray Section of the Division of Pure Physics as project scientist. It was designed to investigate auroral activity 60 to 100 miles above the earth, using instruments to measure ionization densities, temperatures and structures, to count high energy charged particles, x-rays, neutrons and micrometeorites and to record the spectrum and intensity of light emitted by the aurora.

The instruments were designed and provided by the Universities of Saskatchewan and Western Ontario, the Defence Research Telecommunications Establishment, and the Space Electronics Section, the Cosmic Ray Section and the Upper Atmospheric Research Section of NRC. The rockets were manufactured by Bristol Aerospace Ltd. of Winnipeg.

Dr. C. D. Anger of the University of Alberta, Calgary was the project scientist for the second NRC Black Brant 2A. This experiment was designed to make simultaneous x-ray, particle and optical measurements from rocket, balloon and ground-based instruments at a time of enhanced auroral activity. Eight large balloons of 60,000 cubic foot capacity were launched in connection with this experiment, carrying instruments to heights of 104,000 feet, prior to and during the rocket flight.

To cope with the harsh Arctic winter months, all launchers from which rockets

are fired at Churchill are housed in specially designed buildings to provide a maximum of protection for both the rocket instrumentation and the men who must assemble and install them.

When the rocket has been installed on the launcher, a moulded fiberglass clam-like heat shield is closed about the rocket and heat is forced through this enclosure over the rocket while it is in an elevated position awaiting a suitable auroral event. Approximately one minute before firing, the heat shield is opened remotely from the blockhouse by the Test Conductor, allowing the rocket to be launched at a suitable temperature, despite an air temperature of some 40 degrees below zero.

The range maintains a variety of scattered temporary photographic and instrumentation sites, some accessible only by helicopter. They extend as far north as Eskimo Point in the Northwest Territories, and south on the Canadian National rail line to Sipewisk on the northern end of Lake Winnipeg. These sites are manned by the Churchill Research Range personnel for weeks at a time to provide scientists with data essential to the success of a rocket flight.

Helicopters are normally used for support of these outlying sites but a more important role for the twin-motor machines is recovery of scientific payloads which have been parachuted back to earth after gathering geophysical data and atmospheric samples. The helicopters are directed to the recovery area by one of the three highly accurate radars in use at the range.

The radars are designed primarily for tracking of the metal shell of the rocket, but have available closed circuit television as an optical aid and infrared-sensors to follow the flame of the rocket's propellant.

This sophisticated system, combined with beacon transponders (which receive the radar signal and then retransmit amplified impulses back to the radar) within the rocket's nose cone, provides an extremely accurate tracking system to almost 1,000 miles. The radar system was specifically designed to withstand the Arctic environment experienced in Churchill, and is capable of tracking a target the size of a basketball, travelling at speeds in excess of one mile per second, and recording exact positions in a form prepared for evaluation on modern high-speed digital computers.

Since the majority of rocket research at Churchill is aimed at solving the problems of the troublesome but beautiful Aurora, another type of support is required to assist the scientist in his experiments.

This support is in itself an experiment and comes in the form of Auroral Forecasting. Since the Aurora is neither always present nor constant in intensity or configuration, it is of considerable value to be able to predict its occurrence and brilliance to aid in scheduling the various scientific rocket ventures into the Aurora.

Auroral Forecasting involves the study of Solar Storms which produce tremendous quantities of energy, some of which arrives in the vicinity of the earth, enhancing the solar energy which normally provides heat and light to the earth. The storms have their greatest effect on the earth when they occur on the side of the sun closest to the earth and when they occur near the sun's equator. Since the sun rotates on its axis much as the earth does, the effects of the storms tend to repeat in 27-day cycles and this process may last for as many as 10 cycles.

Solar Storms may be detected by optical and radio telescopes and directly by other electronic instruments. Data from various observatories are used to establish cycles of high probability of auroral occurrence since the excessive energy of solar storms apparently frequently turns up as intense Auroral displays.

Recovery of rocket nose cone by helicopter.

Blood Cooler

A National Research Council team and an Ottawa neurosurgeon have developed a blood cooler which promises to make an important contribution to brain surgery.

The cooler, or heat exchanger, which has been used experimentally with animals, will extend to an hour or more the length of time a surgeon can conduct a brain operation without blood flow through the brain.

During some neurosurgery, blood circulation through the brain must be stopped entirely. This has placed a severe limitation on neurosurgery because the brain under normal conditions cannot withstand circulatory arrest for more than a few minutes.

The brain consumes large quantities of oxygen when the body is at normal temperature. However, this need for oxygen can be reduced considerably by cooling the brain tissues.

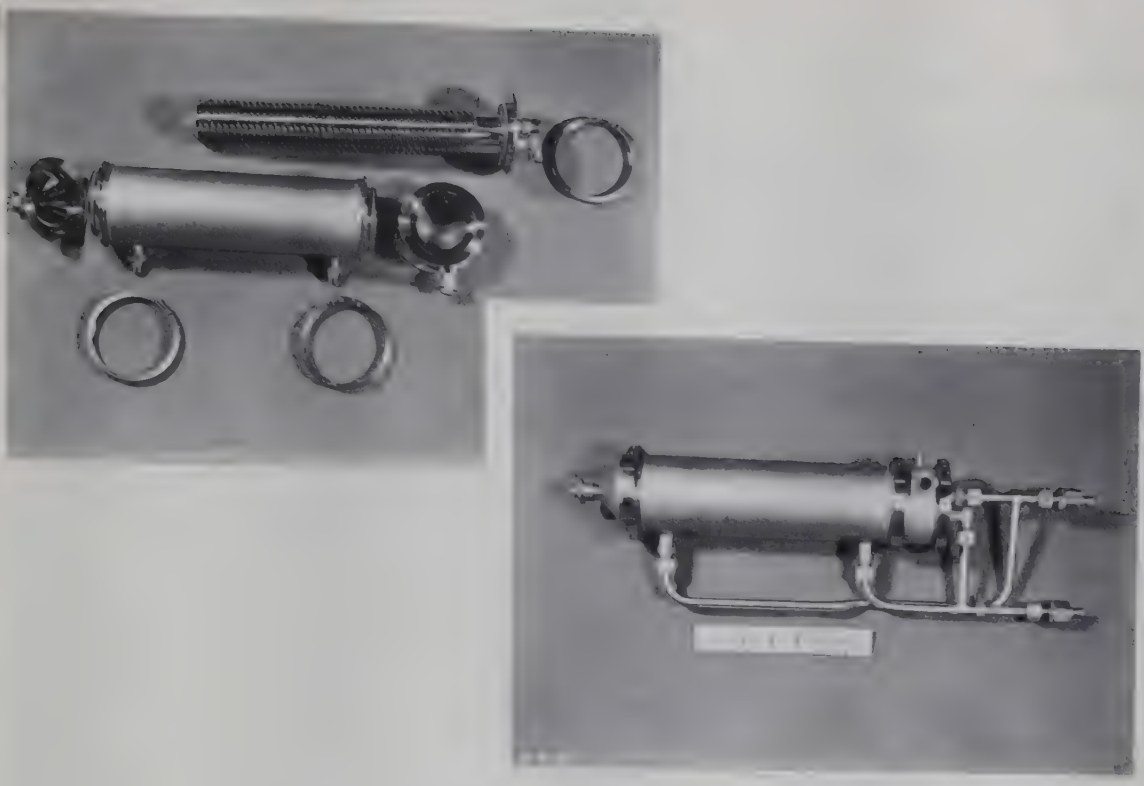
There are two conventional methods for lowering the brain temperature before surgery—covering the patient with a cooling blanket or bathing the patient in ice. These two methods make it possible for a brain operation to last about 10 minutes. Longer operation periods can be achieved by cooling the blood with a heart-lung machine but this involves a major operation before the brain can be touched.

The newly-developed heat exchanger lowers only the temperature of the blood flowing through the brain. Blood temperature throughout the rest of the body remains substantially normal.

The cold blood passing through the brain reduces the temperature of the brain tissues from a normal 37 degrees centigrade to about five degrees. This makes it possible for the neurosurgeon to cut off the supply of blood to the brain for an hour or more.

The new blood cooler was developed jointly by Dr. Eric W. Peterson and an engineering team headed by T. Ray Ringer of the Division of Mechanical Engineering's Low Temperature Laboratory. Dr. Peterson and Mr. Ringer, head of the laboratory, have been working on the development of the cooler for 2½ years.

Dr. Peterson (left) and Mr. Ringer spent 2½ years developing the blood cooler.



Components of heat exchanger (top); assembled unit (right).

Dr. Peterson feels that the blood cooler will be most valuable in operations for brain artery aneurysms or ballooning blood vessels. If one in the brain bursts, death is almost immediate.

The cooler also is expected to be effective in operations to remove big vessel tumors, cancerous brain tumors and inoperable invasive tumors at the base of the skull, and in treating head and neck blood-vessel diseases.

The actual cooling of the blood takes place in a cylindrical heat exchanger, which is assembled like a screw inside a jacketed casing. Ice water, between zero and a half degree centigrade, flows through the casing's jacket and also inside the screw.

Blood, flowing in the opposite direction to that of the water, moves along the screw thread and is cooled from all sides. This counter flow of the blood gives maximum heat-exchange efficiency.

In experiments with animals a plastic tube is connected to the femoral artery in the thigh. Blood flows from the body to the heat exchanger where it is cooled. The cooled blood returns to the body through a tube attached to the carotid artery which supplies blood to the brain.

After the cold blood passes through the brain it flows back into the body through the jugular vein. However, the torso temperatures must be maintained above 28 degrees centigrade, the limiting temperature for the heart.

This is accomplished by placing a blanket with high frequency heating coils on the chest. The induction heating from the blanket is sufficient to maintain a safe temperature.

Once the brain has been cooled, the surgeon clamps the tubing to stop the flow of blood to the brain. He also ties a tourniquet around the neck muscles to stop blood entering the brain through vessels leading from the head and neck muscles. The vertebral arteries are clamped to prevent warm blood reaching the brain by these arteries.

Mr. Ringer says one of the major advantages of the cooler is that no equipment is required to pump blood through the heat exchanger. Resistance along the flow path is almost negligible, requiring less than five per cent of pressure developed by the heart.

The system also has a built-in safety factor which prevents freezing of the blood by the heat exchanger which might produce fatal results. The water which is pumped through the exchanger is cooled by passing it over crushed ice. As the water is always slightly above the freezing point, there is no possibility of freezing the blood.

Seaweed Cultivation

Scuba diver collecting seaweed for cultivation studies.

Studies have been launched at the Atlantic Regional Laboratory of the National Research Council on the application of scientific agriculture to the cultivation of seaweed.

The research was started after processors in this expanding industry expressed concern that known sources of supply will not be sufficient to keep pace with future demand. This view was emphasized at the Fifth International Seaweed Symposium held in August, 1965 at Halifax.

The value of seaweeds harvested in Nova Scotia, New Brunswick and Prince Edward Island now is about $1,000,000 annually. Extracts obtained from species such as Irish Moss, kelp and rockweed find more than 40 different uses in the food, pharmaceutical and textile industries and in agriculture.

This is a considerable industry to be based mainly on the collection of rather widely-scattered wild plants. And further growth of the industry will place an additional demand on known beds of the commercially important species.

"Surveys probably will reveal new sources," says Dr. A. C. Neish, Director of ARL and head of the Laboratory's Plant Physiology Section. "But it is quite possible that cultivation of selected species of seaweeds will become necessary if the industry is to realize its full potential."

The seaweed cultivation studies have been initiated on a small scale. However, it is hoped that this work can be expanded by the establishment of a field station.

"The purpose of this phase of the work is to learn what environmental factors control the growth of different species of seaweeds," says Dr. Neish.

"We need answers to such questions as why some species grow only in exposed areas, or at certain depths, or only in the presence of other species or at certain seasons. We want to see whether breeding and selection will produce better varieties; in short to apply the principles of scientific agriculture to marine plants."

Surveys by scientists of ARL and the Nova Scotia Research Foundation show that about 300 species of seaweeds grow in Canada's Atlantic coastal waters. These surveys are far from complete and additional species certainly will be discovered.

The survey work was carried out by automobile trips to selected points where seaweeds were collected at low tide. On some trips a boat was hired and seaweeds growing below low-tide level were collected by dredging or scuba diving.

Although most species of seaweeds grow in the intertidal zone, where they are fully or partially exposed at low tide, a considerable number of species grow well below the surface. It is in deep water that the large weeds are found. Agarum, a species of kelp commonly known as the sea-colander, has been found growing in extensive beds at a depth of 50 to 60 feet. Although rarely seen, this is an abundant seaweed on the Atlantic coast of Nova Scotia.

Another example of an interesting seaweed recently discovered in depths of around 100 feet five miles offshore, is a red alga (Polysiphonia arctica) which was not previously found growing in this area.

Five species of seaweeds now are being harvested commercially in the Atlantic provinces—dulse, Irish moss, Ascophyllum, Gigartina and Furcellaria. Dulse is sold for human consumption and the other seaweeds are processed for production of gelling agents, such as sodium alginate and carrageenan, which find a wide use in the food and pharmaceutical industries.

Ascophyllum is processed in Nova Scotia for sodium alginate, and the red seaweeds (Irish moss and Gigartina) are sold to processors in the United States. Furcellaria is exported to Denmark.

One of the most important gelling agents found in seaweeds is agar. There are no species in the Atlantic provinces being used commercially for production of agar but a seaweed (Gracilaria) which contains a gelling agent similar to agar grows in the warmer waters of this region.

Little is known about the chemistry of most of the species of seaweeds found on the Atlantic coast. However, chemical studies continue to reveal new and interesting compounds, some not previously found in nature.

Dopamine, a compound related to adrenalin and not previously found in algae, has been found in relatively large amounts in a green alga (Monostroma). This seaweed is the richest plant source known for this compound.

Commercial potentialities for these compounds remain to be assessed.

Dr. J. L. McLachlan of ARL's Marine Botany Section, is one of the key scientists in the Laboratory's seaweed research program. He is shown examining specimens of marine microorganisms grown under conditions of pure culture.

Airborne Simulator

An important tool to aid in the design and development of vertical and short take off and landing aircraft (V/STOL) has been built by the National Aeronautical Establishment of the National Research Council.

The Establishment's Flight Research Section has converted two Bell helicopters into airborne simulators to explore the flight and control system characteristics which will be required in V/STOL aircraft of the future.

With the simulators, the section is studying these required characteristics under actual flight conditions, and is training pilots to fly vertical and short take off and landing aircraft. And this is being done before such aircraft have been built.

One of the two airborne simulators already has been used to study the characteristics of the tilt-wing vertical take off and landing aircraft built by Canadair Ltd. of Montreal. This aircraft, known as the Canadair CL-84, flew for the first time on May 7, 1965.

Before the CL-84 actually flew, the simulator was used to determine some of the characteristics which would be encountered in flight. It was possible to thoroughly familiarize the Canadair pilots with these characteristics well before the CL-84 was flown.

A. D. Wood, head of the Flight Research Section, says the pilots stated that the simulated flying characteristics of the CL-84 closely resembled the characteristics they found later, when they actually flew the aircraft itself.

Work with the simulators forms part of a large-scale research program by NRC on the design of both vertical and short take off and landing aircraft. Such aircraft will be ideally suited for service in remote and unsettled areas of Canada and other countries, where conventional runways cannot be built, and in populated urban areas where space is at a premium.

The broad objective of the research is to study the interrelationship between the task to be performed by the aircraft, the control system of the aircraft and the function of the pilot. The aim is to establish minimum acceptable and, where possible, the most favorable design criteria for the control system with which the aircraft is to be equipped.

Information obtained will make it possible to determine the kind of control system V/STOL aircraft will require for safe, efficient and economic operation.

For example, it takes a great quantity of power to lift a vertical take off and landing aircraft off the ground vertically, using either propellers or jet engines. Designers of such aircraft want to use all the power possible for lift, and to divert a minimum amount of power to the control system.

In the operation of the simulator, two pilots are seated side by side in the helicopter. The pilot on the left acts as safety pilot and program manager and the evaluation pilot on the right operates electric flying controls. The evaluation pilot's controls are identical to those of the safety pilot, except that they generate electric signals instead of mechanically controlling the rotors.

Airborne simulator being prepared for test flight by team from NAE's Flight Research Section. Left to right—D. M. McGregor, Mr. Wood, R. E. Smith and Keith Davidson.

After the helicopter becomes airborne under the control of the safety pilot, the evaluation pilot takes over control, flying the aircraft in the ordinary manner. However, in operating his controls electric signals are sent to an analogue computer in which electric models of flight and control characteristics of VTOL aircraft have been set up.

In response to these input signals, the computer then sends output signals which activate hydraulic servo systems controlling the rotors, causing the helicopter to simulate the characteristics of the electric model.

Special instruments measure the actual motion of the helicopter and compare this with the motion required by the electric model. The computer acts in such a way as to reduce to zero the difference between the actual and desired motion. The behavior of the helicopter thus becomes that of the model.

Mr. Wood says the net result is that the helicopter may be made to simulate the actual flight and control characteristics of a great variety of VTOL, as well as other types of aircraft.

The safety pilot can take over control of the helicopter whenever the aircraft's behavior becomes dangerous, as is sometimes the case when the electric model has poor characteristics. He does this by overriding the other pilot's controls or by disengaging the electric model.

Without using an airborne technique, it is difficult to completely simulate the total flying environment. Ground based simulators do some things well but in studies of the flying qualities of an aircraft as a whole, it is better to put the aircraft and pilot in a true flight environment.

In the airborne simulator, the pilot knows that there is nothing artificial about his surroundings. He is in the air and his experiences are real. A pilot can fly by reference to his visual environment and can, for example, land the aircraft by visual means. He can also fly and make a landing approach by instruments alone.

The effect of turbulence also can be studied with an airborne simulator. Tests conducted only in still air can be misleading. Consequently, tests are conducted in the presence of an appropriate degree of turbulence, which is fed synthetically into the electric model.

Another feature of the airborne simulator is that the electric model can be changed at will. This makes it possible to study a variety of VTOL flight characteristics during a single test flight.

An example of an important flight characteristic affecting aircraft behavior is that of damping.

An automobile without shock absorbers has insufficient damping. It will continue to bounce after hitting a bump and the driver will find it difficult to control.

The ability of the pilot to fly an aircraft accurately depends, among other things, on the power of the control system and its damping. If there is not enough damping the aircraft will tend to oscillate. If there is too much damping it will be sluggish to handle.

"By investigating combinations of control power, damping and many other stability and control criteria, we are able to determine boundary values within which VTOL and STOL aircraft can be operated," Mr. Wood says.

Simulator was used to determine flight characteristics of Canadair's tilt-wing VTOL aircraft.

Freight Damage Research

Aerial view of NRC's new laboratory complex for studies into damage caused to goods during shipment by freight car.

Every year railway companies in Canada and the United States pay out huge sums of money to cover damage caused to goods during shipment by freight car.

The amount paid in such claims by North American railways has been rising steadily over the years. It reached $142,000,000 in 1964 and the current estimate for 1965 is in excess of $150,000,000.

However, it has been estimated that the amount paid annually in claims covers only about one half of the total actual damage caused to goods being moved by railway freight car.

A major research project has been initiated by Canadian railways, in co-operation with the National Research Council, in an effort to reduce this serious economic loss—a study of the dynamics of long trains and of means for reducing lading damage.

Part of the research is being conducted by NRC's Division of Mechanical Engineering at a new laboratory complex in the Uplands area near the Ottawa International Airport.

S. H. G. Connock, head of the Division's Instrument Section, says the objective of the studies is to reduce the amount of damage now being caused to freight by providing improved protection through changes in the design of freight cars and their components, including coupling equipment, improved loading patterns, and draft gears, and also by improving the longitudinal stability of long trains.

"In order for this objective to be achieved we must have a better understanding of the behavior of various classes of goods and of the freight cars and their components under conditions of impact and also as components of long trains," Mr. Connock says. "This information is being sought in a program of impact and road tests which was recently started."

Special facilities, the only ones of their kind in Canada, have been built at the Uplands site to permit railway freight cars to be impacted and coupled under controlled test conditions.

The test site includes a 200-foot section of railway track in the form of a ramp with a 15 per cent grade, a special "Ram Car" and a laboratory building in which instrumentation of cars is carried out, together with a complex of track including a wye ("Y" - Track) for the turning of cars.

A typical impact study involves the use of two or more railway freight cars. The car to be impacted (the "anvil" car) is located on level track at a selected distance from the bottom of the ramp. A winching station at the top of the ramp is used to pull the impacting ("hammer") car up the grade to a preselected position so that the required speed will be achieved at the point of impact on the level section of track. The "hammer" car is released by a special trip mechanism.

Specially designed equipment is being used to record what happens to lading and to freight cars and their component parts under different degrees of impact.

A special photographic recorder devised by C.A.M. Smith, one of Mr. Connock's associates in the studies, also permits an entire sequence of an impact to be recorded graph-like on a short length of film. This special film strip, shown below, has been dubbed a "Smithogram".

Road tests also are being conducted in collaboration with Canadian railways in studies of train dynamics, car riding characteristics and the behavior of freight resulting from train action. This has involved studies on short runs in Ontario and Quebec and long runs from Ottawa to Vancouver and return.

One such study was of the effect of spring restraint of the axles. This was achieved by a specially designed form of wedge plate with rubber as the spring material. A marked reduction in lateral (sideways) motion of the car axles resulted with an associated reduction in transverse forces on the car itself.

A computer study of the behavior of long trains is also being made. From data derived from impact tests and physical measurements made on trains in road tests, a mathematical model has been devised so that typical trains with a mixture of cars of various types running over typical grades can be simulated. Thus, the effect of a proposed design change in running equipment (for example, draft-gears) on the behavior of the train as a whole can be studied without incurring the cost and possible risk that would be involved by tests in an actual train.

View of test area with ramp in background (above).

Impact recorded graph-like on a short length of film dubbed a "Smithogram" (right).

New Aircraft For Forestry And Agriculture

The National Research Council has set up an Associate Committee to guide the technological development and use of aircraft especially suited for the agricultural and forestry industries of Canada.

The 15-member committee, made up of representatives of industry, government and universities, will be known as the Associate Committee on Agricultural and Forestry Aviation. Its chairman is Professor P. H. Southwell of the School of Agricultural Engineering of the University of Guelph, Guelph, Ontario.

Aircraft are being used to an increasing extent by the two industries as a means of transport and for two specific operations—forest fire fighting and insecticide and pesticide spraying. However, only a few of the aircraft being used have been designed specifically for agriculture and forestry work.

A report prepared by L. E. Philpotts of the Canada Department of Agriculture shows that in 1965 a total of 302 aircraft were used by the agriculture industry for transporting supplies, spare parts and personnel and for checking such things as fences, cattle and farm buildings. These aircraft flew 17,327 hours.

A total of 147 planes were used in 1965 by this industry for spraying operations. They flew 11,486 hours and for the first time in Canada more than 1,000,000 acres of farm land were sprayed from the air. This represents an increase of 150 per cent since 1957.

The forestry industry is making increased use of planes as water bombers in fighting forest fires, for spraying operations to control the spruce budworm, and for the movement of men and equipment. This industry has also been using aircraft for tree-seeding operations.

The Committee's objective will be to review, promote and advise on research and development programs covering five areas:

Water bomber aircraft fighting forest fire in British Columbia

1. The design and performance of equipment for the dispersal from aircraft of materials such as water and chemicals.

2. The design and performance of aircraft in which this equipment will be carried and operated.

3. The assessment and prediction of the performance of such aircraft and the equipment they carry under different climatic and flight conditions. This work also will include studies to determine the efficiency of equipment in handling materials to be dispersed and the effect such materials have on the operation of this equipment.

4. The improvement of operational techniques for such aircraft, including ground control systems and the training of pilots and ground personnel.

5. The problem of the safety of aircraft that carry chemicals and the toxic effect of chemicals on aircrew.

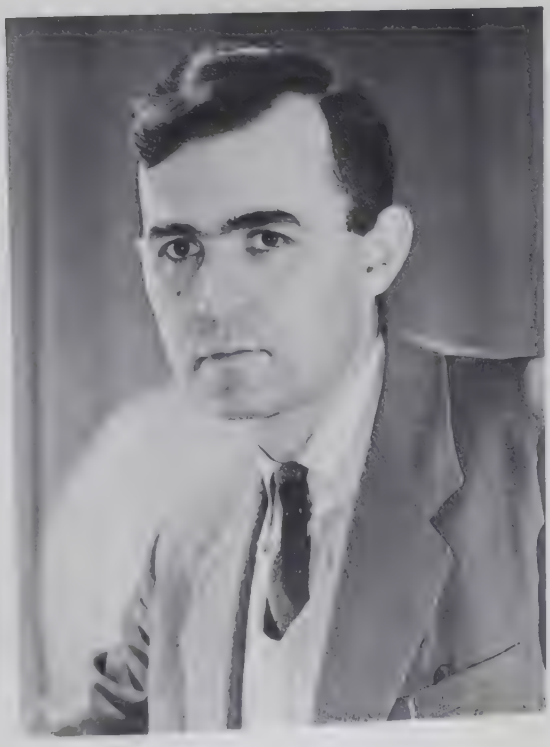
One of the first aims of the Committee will be to establish an information centre for all existing data on agricultural and forestry aviation. It likely will be centred within the facilities of NRC's National Aeronautical Establishment.

The Committee hopes to be able to obtain the services of a consultant to gather this information. It also is considering the organization of a symposium next year to bring together individuals and organizations involved in agricultural and forestry aviation.

An invitation will be extended by the Committee to the International Agricultural Aviation Congress to hold its 1968 meeting in Canada.

Light aircraft conducting spraying operation.

Appointment



Dr. James A. Morrison, 47, was appointed Director of the Division of Pure Chemistry of the National Research Council of Canada, effective April 1. He succeeds Dr. W. G. Schneider, who was appointed Vice-President (Scientific) of the Council on September 23, 1965.

Dr. Morrison joined NRC's Division of Pure Chemistry in 1946. His work has been in the fields of surface chemistry and thermodynamics.

Born in Medicine Hat, Alberta, Dr. Morrison obtained his B.Sc. in 1940 and his M.Sc. in 1941 from the University of Alberta. In 1942 he was awarded an NRC Fellowship and obtained his Ph.D. from McGill University in 1943.

Following graduation he joined the Chemical Warfare Directorate. He remained with the Directorate until 1945 when he went to Pennsylvania State College on an NRC (U.S.) Fellowship in Chemistry.

Dr. Morrison is a Fellow of the Royal Society of Canada.

Council Appointments

Prof. Bonneau

Dr. Currie

A. B. Hunt

Dr. Piché

Dr. Shemilt

Four new appointments have been made to the National Research Council of Canada by the Governor General in Council.

The four new members are Dr. Balfour Watson Currie, Dean of Faculties and of Graduate Studies, and Director of the Institute of Upper Atmospheric Physics, University of Saskatchewan, Saskatoon; Albert Brewer Hunt, Vice-President, Research and Development, Northern Electric Co. Ltd., Ottawa; Dr. Lucien Piché, Vice-Rector, University of Montreal, and Dr. Leslie W. Shemilt, Head of the Department of Chemical Engineering, University of New Brunswick, Fredericton, N.B.

Louis-Philippe Bonneau, Professor of Applied Thermodynamics and Vice-Rector, Laval University, Quebec City, has also been reappointed for a further three-year term.

The appointments followed the expiration on March 31 of the terms of office of five members of Council. They are Prof. Bonneau; Dr. Roger Gaudry, Rector, University of Montreal; Dr. Paul Lorrain, Head of the Department of Physics, Faculty of Science, University of Montreal; Dr. J. H. Shipley, Vice-President and Director, Canadian Industries Limited, Montreal, and Dr. R. J. Uffen, Dean, College of Sciences, University of Western Ontario, London, Ontario.

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Cover: Night view of giant radio telescope at the Algonquin Radio Observatory.

Photo Credits: Thalidomide child by Rehabilitation Institute of Montreal; Dr. Tupper by Van's Studio Ltd., Ottawa; Radar by Canadian Marconi Company; "thermoprobe" by Daystrom Ltd.; others by NRC.

Directory

More than 3,500 scientific research projects in progress in Canadian universities are listed in a new National Research Council directory.

The directory lists university research projects in those areas of science and engineering which are supported by various NRC programs. It also includes projects in experimental psychology, architecture, physical geography and dentistry. Research in faculties of medicine is not covered except for certain departments of bacteriology and biochemistry.

Entitled "Canadian Universities: Research in Science and Engineering," the directory has been prepared by the Council as part of its broad responsibilities for science in Canada. It is similar to a publication issued for many years in the United Kingdom by the Department of Scientific and Industrial Research and the British Council.

Publication of a directory of this type has been under consideration by NRC for many years. The Council decided to publish an initial directory on an experimental basis as a result of the great increase in research in Canadian universities.

No decision has been made on future policy for publication of such a directory. This will depend on how much use is made of the initial issue and on how it is accepted by the scientific community.

The directory is based on a survey made in the spring of 1965. All research projects listed were in progress during the 1964-65 academic year.

Algonquin Radio Observatory

First stage of interferometer for solar observations.

National Research Council scientists have been placed in a position to make major contributions to man's understanding of the structure and evolution of the universe.

They now have at their disposal two major installations which will keep Canada in the forefront of world-wide research in the comparatively new but rapidly-evolving science of modern radio astronomy.

The two installations are a giant radio telescope with a 150-foot diameter parabolic reflector and the first stage of a multi-element interferometer. They will make it possible for NRC astronomers to initiate a series of some of the most advanced astrophysical investigations ever to take place on earth.

The first stage of the interferometer is an array of 32 10-foot parabolic reflectors laid out on an east-west line 700 feet long. This installation will ultimately take the form of a "TEE", 2,800 feet long on an east-west line by 350 feet on a north-south line.

Both installations have been built at the National Research Council's Algonquin Radio Observatory, operated by the Council's Radio and Electrical Engineering Division. The large radio telescope is especially designed to collect faint radio emissions from distant objects and the interferometer is especially designed to isolate intense radio emissive regions on the surface of our nearest star—the sun.

The Observatory is located at Lake Traverse in Algonquin Provincial Park, 120 miles northwest of Ottawa, on land set aside by the Province of Ontario for the maintenance of a national radio observatory. The relative remoteness of the site and its location within a provincial park render it comparatively free from radio noise of terrestrial origin, and will permit interference-free observations of celestial radio emissions to be made for many years to come.

The 900-ton radio telescope, begun in 1959, ranks among the most powerful and versatile in the world. Its huge saucer-shaped reflector is capable of receiving the faintest of radio emissions from stars, gas clouds and other objects in space thousands of millions of light years away from earth. Many of these emissions cannot be detected with optical telescopes.

This special attribute or fine resolving power in the microwave band will enable scientists to use the telescope to explore the almost unprobed area of radio sources in outer space with wavelengths shorter than 10 centimeters. It's expected that the telescope will operate at full efficiency to wavelengths as short as three centimeters and will be useful to two centimeters.

The microwave region to be studied provides an area of observation where a most important contribution to astronomy can be made immediately. Measurements in this area will provide data concerning the mechanism of radiation from radio galaxies and newly-discovered quasars or quasi-stellar objects, some of which may be located near the very limits of our observable universe.

Another major capability of the telescope is its ability to measure precisely polarized radiation from sources far beyond our own galaxy. These studies are expected to aid NRC astronomers to improve their theories about the structure and evolution of galactic systems.

A wide range of other research also is in the planning stage, including observations of planetary nebulæ, of the planets themselves, of lunar occultations and galactic polarization.

The radio telescope employs a two reflector Gregorian antenna system. Radio emissions from outer space are first collected by the 150-foot parabolic surface and directed on to a small sub-reflector, located slightly beyond the focal point. The energy is then directed by the sub-reflector into a small horn conveniently located at the center of the paraboloid. The 10-foot diameter sub-reflector and a small cabin are supported by four tubular steel feed legs. This antenna system results in a narrow pencil beam which is fully steerable. The sensitive receiver produces a continuous recording of the received signal in a separate control building, situated about 150 feet from the antenna.

The entire steel structure of the fully steerable reflector, which has an area of 12,000 square feet, is carried on four gear boxes with integral rollers that run on a track 37 feet in diameter. This means that the paraboloid has mobility through 360 degrees.

The paraboloid can be moved through a 90-degree arc. It can thus be tipped so it is almost vertical and at the same time can be turned on its turret through a complete circle.

The reflector is built to exacting standards. Curvature requirements of the steel

Saucer-shaped reflector receives radio emissions from objects in space thousands of millions of light years away from earth.

dish meant the surface had to be accurate to within ⅛ of an inch over the whole of its area.

The multi-element interferometer is designed primarily for solar observations. The 10-foot parabolic reflectors are polar-mounted and remotely controlled in unison so that the whole assembly is able to follow the sun for four hours in the middle of the day.

Radiation from the sun extends over the whole spectrum—from radio waves, infra-red, visible light, ultra violet, to X-rays. It has been found that the 10-centimeter waves and X-rays radiated from the sun follow the same pattern, increasing and decreasing together. The X-rays are absorbed in the upper atmosphere of the earth, creating the ionosphere which is so important for radio communications. The 10-centimeter radio flux passes on through the upper atmosphere with little decrease in strength and serves as an index of the X-ray emission from the sun. It has been monitored by NRC scientists since 1946.

Short-term changes in solar radiation of the order of minutes can be obtained from consecutive scans of the sun with the interferometer. With the aid of optical sunspot information, it is expected that a great deal will be learned about the effects of solar radiation on the earth's magnetic field.

Some of the most valuable information that the interferometer is likely to provide will come from a sustained program of observation. Little is known about the evolution of radio emissive regions of the sun, a process which covers a few months. Far less is known about how (or indeed, if) the pattern of evolution changes during the 22 years of a complete sunspot cycle. The magnetic fields associated with sunspots change significantly during this 22-year cycle and much can be learned about these fields by observing their influence on the polarization of the radio emission.

Technician David Fort operating the telescope's control panel.

The Algonquin Radio Observatory is operated as a Section of the Radio and Electrical Enginering Division under the management of Vance Rintoul, Station Engineer. Over-all policy will be determined by a high-level committee representing the universities and other government departments as well as NRC. The chief users of the observatory will be the Radio Astronomy Section of the Radio and Electrical Engineering Division, the Astronomy Departments of several universities, and possibly other government departments. The scheduling of programs will be arranged by a committee of the users.

The 150-foot telescope came into existence under the guidance of a planning committee including W. A. Cumming, Antenna Engineer, NRC; N. W. Broten, Radio Astronomer, NRC; H. E. Parsons, Mechanical Engineer, NRC; Dr. D. A. MacRae, Astronomer, University of Toronto; and Dr. George Harrower, Astronomer, Queen's University, Kingston, Ont. The committee decided to model the telescope after the very successful Australian radio telescope at Parkes, but to design for operation in the microwave region which has been largely neglected to date.

In addition to the two large telescopes, several important but smaller instruments are in operation at the Algonquin Observatory. They include a 33-foot parabolic telescope useful to study wavelengths as short as one centimeter.

Technician inspects sub-reflector.

Thalidomide Study

Thalidomide children are demonstrating a tremendous capacity to adapt themselves to their malformation.

This is one of the conclusions reached by a research team at the Rehabilitation Institute of Montreal, which is studying the intellectual and emotional potentials of thalidomide children and the psychic reactions of parents to their children's handicaps.

The team is headed by Dr. Thérèse Gouin-Décarie of the University of Montreal's Institute of Psychology, who is being assisted in her research with a $16,000 grant from the Medical Research Council of Canada.

Dr. Décarie says the severity of malformation in thalidomide children appears to bear little relation to their ability to develop intellectually and emotionally.

"We expect the children will show the whole spectrum of intelligence and emotional development," she says. "The degree of malformation appears to have little weight, which is hopeful for the mothers of these children".

In December, 1963, the institute examined 33 thalidomide children ranging in age from one year, five months, to two years, six months. Twenty-two of these children had limb deficiencies, varying from a simple malformation of the hand or feet to malformations of all four limbs.

At this stage it was realized that it would be exceedingly difficult to assess the intelligence of malformed infants. Yet it was important for the parents and the prosthetists to know as early as possible about the learning capacities of these severely handicapped individuals and about their possibilities of integration into the community.

Standard baby tests were sufficiently wide in scope to study the mental and emotional potential of the less seriously handicapped. The researchers developed their own psychological instruments to study the other children.

The first full-scale psychological evaluation of the 22 children took place at the Institute during May and June of 1964.

"The children demonstrated tremendous capacities of adaptation," Dr. Décarie says. "A little girl who could not manage a two-piece puzzle with her weak digits, wet the pieces with saliva from her tongue and gluing her tongue to them succeeded in reconstructing the puzzle."

Brigitte was born without arms, and has only rudimentary fingers.

Prosthetic arms fitted at Rehabilitation Institute are powered by carbon dioxide. Brigitte uses her fingers to operate valves attached to a corselet.

Dr. Thérèse Gouin-Décarie.

One of the children has aplasia of the tongue, believed unique among thalidomide cases. This child has learned to speak in an intelligent way although the researchers as yet do not know how he does it.

A child without legs, when placed on the floor without her prostheses, has developed four different modes of locomotion. She can, for example move on her seat shuffling along with a kind of gallop crawl.

"They have tremendous possibilities of reaching, in their own ways, goals we never thought possible," Dr. Décarie says.

Follow-up studies of each child started last January. Each child is being seen for a whole week, with their mothers, to determine his or her level of development. The psychological reactions of the mothers also is investigated.

"The data obtained will be systematically compared with previous information," Dr. Décarie says. "Through a better understanding of the growth of these children, we hope, sometime in the future, to be able to reduce even slightly the traumatic effect of the thalidomide tragedy."

A third follow-up study is expected to take place after the children have started school.

Dr. Décarie says that when the study is completed the researchers hope to be in a position to make recommendations to parents and the medical profession on the best way to rear these children.

There are about 100 thalidomide children in Canada being cared for in centres in Montreal, Toronto and Winnipeg under programs of co-operation between federal and provincial governments. However, the only research similar to that in progress at the Institute is in Munich, Germany.

Unattended Lighthouses

Radio remote-control systems for use in unattended lighthouses have been developed by the National Research Council of Canada at the request of the Department of Transport.

Extensive tests with the systems show that it now is possible for lighthouses without easy access to electric power to be operated efficiently without resident personnel.

Two lighthouses now are using systems developed by the Navigational Aids Section of NRC's Radio and Electrical Engineering Division. They are Pelee Passage Lighthouse in Lake Erie and Sidney South Bar Lighthouse in the Sydney, N.S., harbor.

Remote control equipment was installed two years ago at Pelee Passage Lighthouse, which marks the last course change for ships on the approach to the mouth of the Detroit River. This lighthouse, located on a sandbar 3½ miles northeast of the north end of Pelee Island, is difficult to reach and the Transport Department had trouble obtaining and keeping lighthouse personnel.

The equipment at the lighthouse consists of a fog alarm, a main beacon light and a standby beacon light. The fog alarm is remote controlled, while the beacon lights are controlled at the lighthouse by daylight switches.

Electronic in operation, the fog alarm uses a 110-volt lead-acid battery for its power source. It is switched on and off by a radio dial system from the Southeast Shoal Lighthouse, located about seven miles southeast of the Pelee Passage Lighthouse.

A second radio channel is used to switch on a monitoring transmitter for a two-minute period to determine whether the fog alarm is working. A microphone picks up the sound of the fog alarm and the transmitter relays it by radio to a receiver at Southeast Shoal Lighthouse.

The monitor transmitter also can be used to determine whether the main beacon light is operating properly. A system of mirrors directs a portion of the rotating light beam into a photo-resistive cell which controls an audio oscillator. A loud speaker connected to the oscillator emits a "beep" whenever the light beam passes the photo cell and the monitor microphone picks up this sound, in addition to that of the fog alarm. To avoid a continuous tone being received during the day, a daylight switch opens the power circuit to the oscillator.

The 12-volt main beacon light receives power from a bank of lead-acid batteries of high capacity, capable of operating the light for a month without automatic recharging. In the event of failure in the main light, a standby light of reduced candle power goes into operation automatically. The standby light is powered by a separate bank of batteries.

Another NRC developed radio control system is operating in the Sidney South Bar lighthouse, located on a sand bar outside the Sydney harbor entrance. It was installed last spring as emergency equipment after a power cable to the lighthouse from the mainland was carried away by ice. As soon as the power line is replaced, the equipment will be installed in another east coast lighthouse which will be operated in the future on an unmanned basis.

Lead-acid batteries for fog alarm and main beacon light.

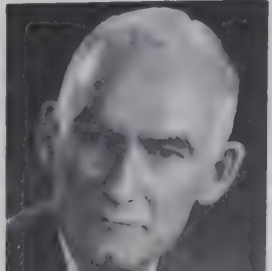
Dr. Gerhard Herzberg, Director of NRC's Division of Pure Physics, received an Honorary Doctor of Science degree from the University of New Brunswick on May 3, 1966, and an Honorary Doctorate degree from the Faculty of Natural Sciences, University of Stockholm, May 31.

Dr. L. E. Howlett, Director of the Division of Applied Physics, was elected Vice-President of the International Commission on Optics for 1966-69 at the Commission's 7th Session in Paris on May 2, 1966.

Dr. Robert F. Legget, Director of the Division of Building Research, was awarded the degree of Doctor of Laws, honoris causa, by Queen's University, Kingston, Ont., on May 14, 1966.

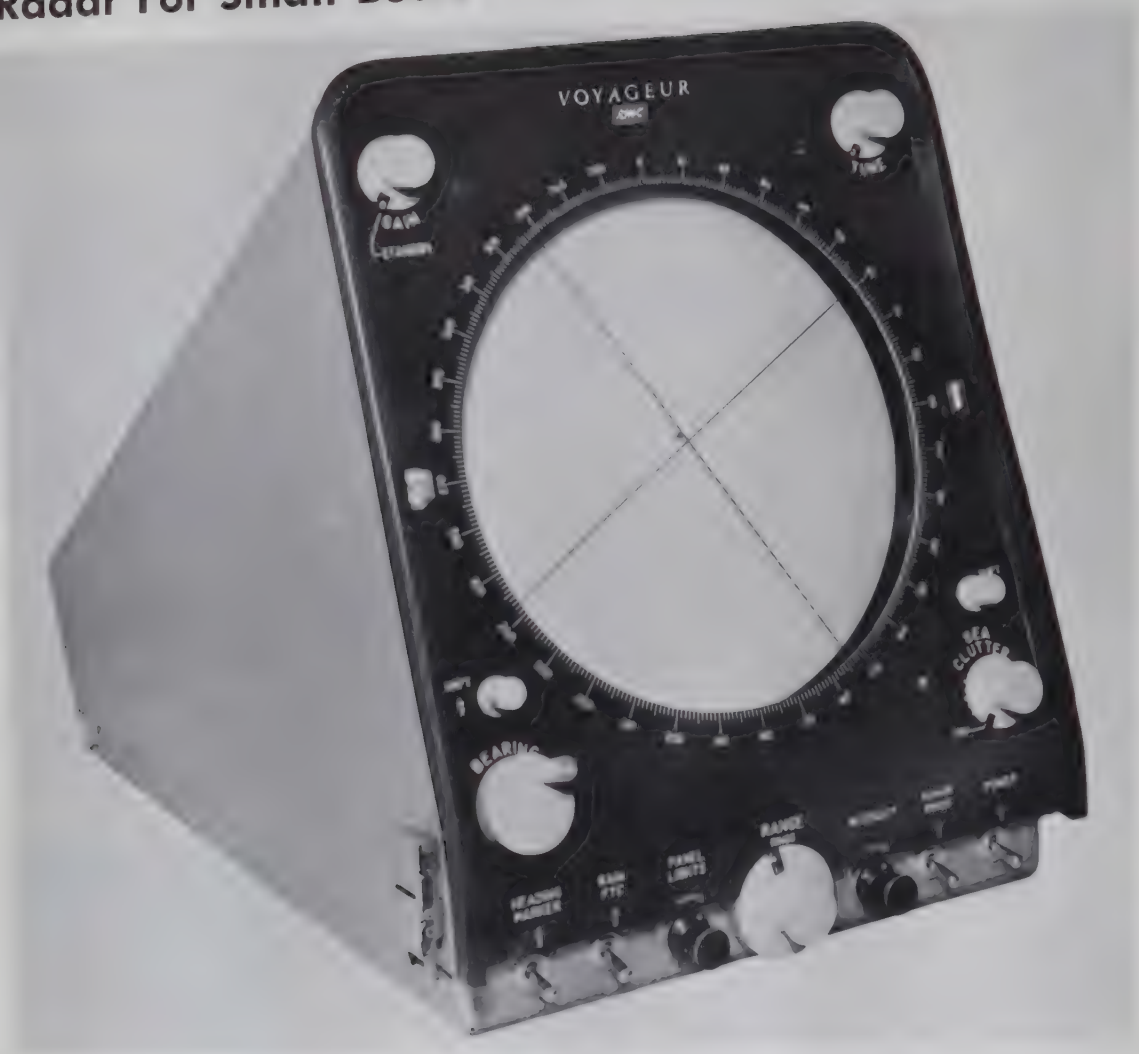
Dr. Peter M. Millman, head of the Upper Atmosphere Research Section of the Radio and Electrical Engineering Division, was appointed a Counsellor of The Smithsonian Institution on April 26, 1966. He is the first Canadian named to the Smithsonian Council.

H. T. Stevinson of the Flight Research Section of the National Aeronautical Establishment received the McCurdy Award for 1966 at a meeting of the Canadian Aeronautics and Space Institute on May 3. The award, highest granted in Canada in the scientific and engineering fields of aeronautics and space research, recognizes Mr. Stevinson's development of the automatic Crash Position Indicator.



Dr. K. F. Tupper, Vice-President (Scientific) of the National Research Council, received an Honorary Doctor of Science Degree from the University of Sherbrooke June 4, 1966.

Radar For Small Boats



Fully transistorized 10-inch display unit with indexed controls.

A battery-powered marine radar for small boats developed by the National Research Council now is being manufactured by the Canadian Marconi Company.

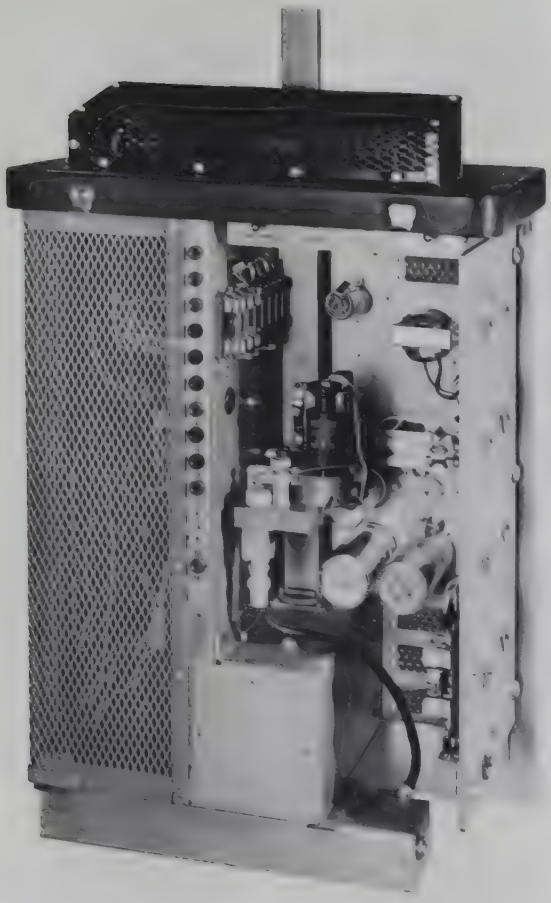
Known by the trade name "Voyageur," the new unit is designed to meet a demand for a reliable, inexpensive general purpose radar for small vessels plying inland and coastal waters.

The versatile, compact unit, developed by the Navigational Aids Section of NRC's Radio and Electrical Engineering Division, is the first fully transistorized medium power marine radar designed and manufactured in North America. Its design has been licenced to Canadian Marconi by Canadian Patents and Development Limited, a subsidiary of NRC.

H. R. Smyth, head of the Navigation Aids Section of REED, says the chief advantages of the new unit are its low cost, ease of installation, low power requirements, economy of operation and radical simplification of service problems. These factors combine to place the acquisition of radar equipment within easy reach of the fishing industry and small boat owners.

The Federal Department of Transport has already reported favorable performance by units it has installed on some of its vessels. Extensive trials have demonstrated that it gives outstanding rough-weather performance—essential for all fishing and coastal applications.

The unit has ranges of one, four, eight and 16 miles on a 10-inch cathode-ray tube. The maximum range is ample for coastal navigation, and the minimum range—35 yards—is sufficiently short for navigation in restricted waterways.



Transmitter-Receiver Unit.

Power is supplied to the radar by a 12-volt storage battery driving a transistor converter. Plug-in adaptors permit efficient change-over to any other practical primary power source.

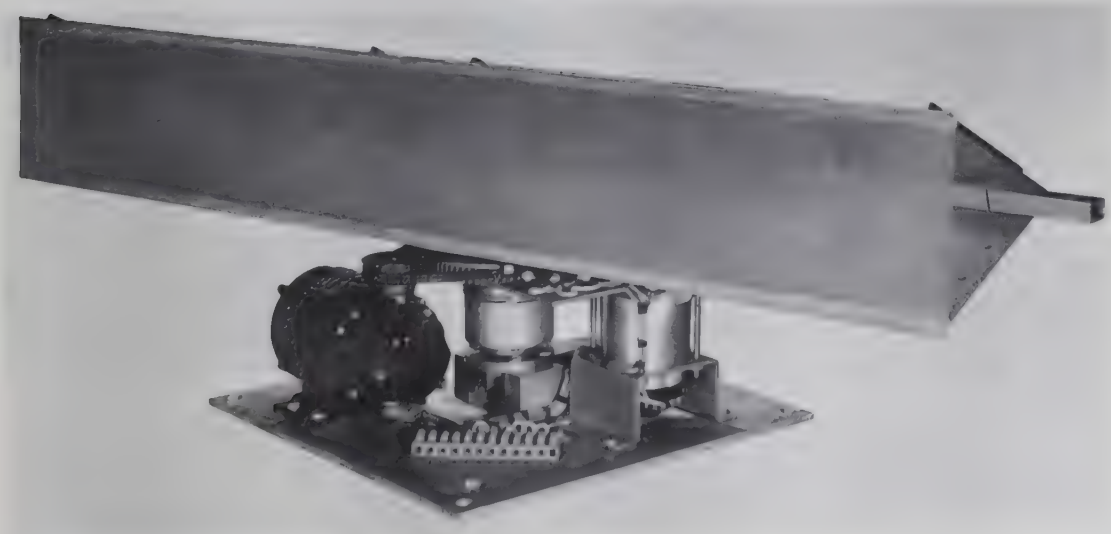
The new radar's main parts have been reduced to two light-weight packages—the display chassis and the transmitter-receiver chassis. They are so compact that they can be installed in the crowded wheelhouse of small vessels, where space is always at a premium.

The display chassis containing the 10-inch cathode ray tube and its circuitry may be either table-mounted or bulkhead-mounted like a wall clock. The transmitter-receiver chassis may be located in an out-of-the-way spot as connecting cable from it to the display chassis can be extended to 20 feet without difficulty. The display package weighs 32 pounds and the transmitter-receiver chassis 37 pounds, permitting them to be handled by one person.

The display circuitry is confined to three plug-in boards, adaptable to printed circuit techniques, and built as complete sub-assemblies. This means that if anything goes wrong the faulty board need simply be replaced and repairs can then be made at a convenient time.

The precision slotted-waveguide antenna, designed by the manufacturer, is of light-weight construction and is protected from wind, water and icing conditions by a radome housing. The complete absence of electronic components gives little need for servicing. The radome, constructed of glass-epoxy and a urethane foam window, combines the properties of ruggedness with complete transparency to microwave energy.

Antenna Unit.



Night Weather Photos

Infrared photographs of the earth's surface and of cloud patterns taken by a United States weather satellite at night have been obtained for the first time by a Canadian ground station.

The photographs were received at a station operated in Ottawa by the Satellite Data Laboratory of the Radio and Electrical Engineering Division of the National Research Council.

The NRC station originally was capable only of receiving photographs transmitted during daylight hours by American weather satellites. However, it now has been modified to receive infrared photographs taken at night by the American Nimbus II weather satellite which was launched May 15, 1966.

Conventional photographs taken in daylight hours by weather satellites and received by ground stations in Canada and the United States make possible increased observation of the earth's atmosphere and contribute to greater accuracy in weather forecasting. They show meteorological details such as cloud formations, weather fronts, jet streams, intense lows, air circulations, hurricanes, as well as ground cover, including ice and snow.

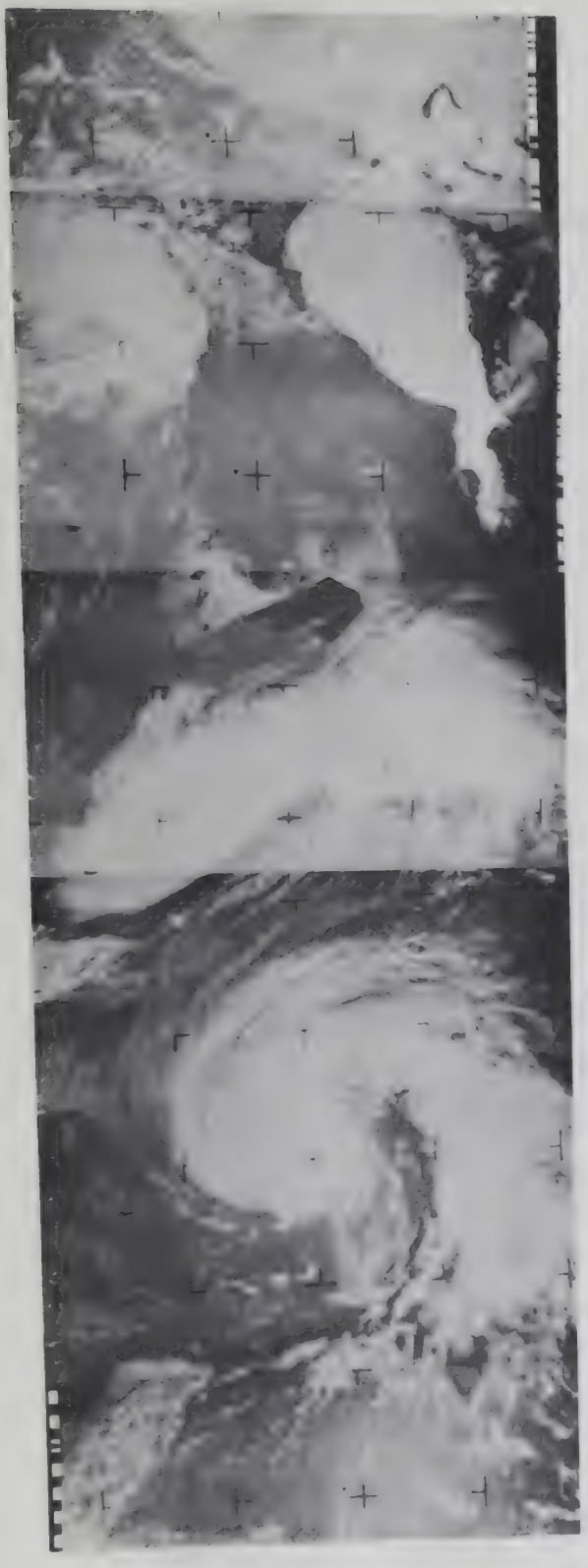
The NRC experimental receiving station was built several years ago following the establishment of the meteorological satellite program of the United States National Aeronautics and Space Administration. It was the forerunner of similar stations recently put in operation by the Department of Transport in Toronto and Halifax as part of its weather forecasting service.

The Nimbus II satellite is able to take photographs at night by means of a high-resolution infrared radiometer system. The satellite-borne system detects minute differences in the relatively faint invisible infrared radiation (heat) emitted by clouds and the earth's surface. It converts the data to electrical signals which are transmitted to earth.

Signals received by the NRC station at night are placed on a magnetic tape and fed into equipment which turns them into strips of photographs. The process involves the use of a high resolution, slow-scan TV screen and a Polaroid camera.

The shades (lightness or darkness) of images in the photographs are directly related to the infrared radiation emitted at night by the photographed objects. For example, warm water areas (such as seas,

This infrared photograph of the east coast of Canada and the United States was received at NRC at 1:17 a.m. June 8, 1966, on the 318th pass of the Nimbus II satellite. The white swirl in the lower right hand section is Hurricane Alma below Florida.



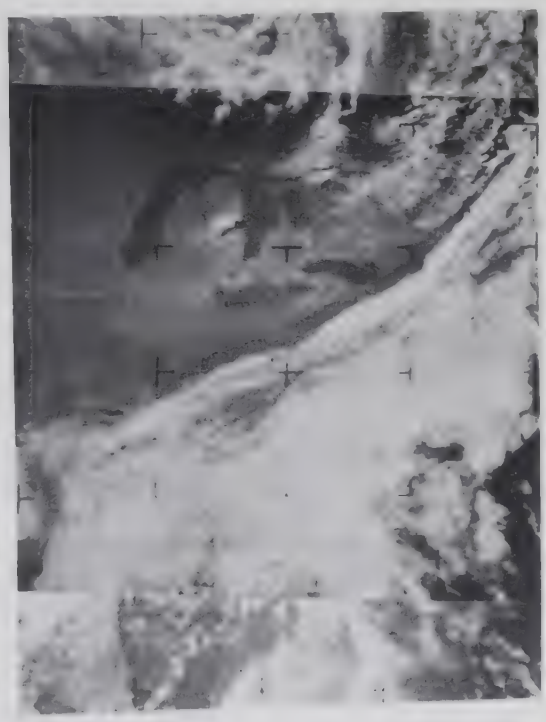
This daytime photograph was received at 12:30 p.m. June 9 during the 338th pass of the satellite. The white swirl in the lower centre section of the photograph is Hurricane Alma moving west of Florida. The black spot in the centre is Lake Superior and Great Bear Lake is clearly visible in the top left-hand corner.

oceans, lakes and rivers) appear dark. Cold mountain tops, snow and ice cover are bright and land is in various shades of gray becoming lighter with elevation.

The intensity of infrared radiation emitted by clouds at night decreases as their altitude increases. This make is possible to determine cloud heights from knowledge of the vertical temperature distribution, giving weather forecasters another tool in the difficult science of meteorology. In future infrared photographs transmitted by satellites may also be useful in detecting forest fires.

The NRC station, along with the other two in Toronto and Halifax, also is receiving photographs from Nimbus II during the day. It is hoped that photographs received daily at Toronto and Halifax from both Nimbus II and Essa II, which was launched into orbit in March, will help the Meteorological Service of the Transport Department to make better and faster weather forecasts.

The use of the daytime photographs in weather forecasting is farther advanced than the use of infrared photographs. Nimbus II has transmitted infrared photographs taken during the day but current research is with photographs taken at night. The main aim at the moment is to make possible round-the-clock use of photographs from satellites in weather forecasting.



All five of the Great Lakes can be seen in this photograph received from Nimbus II on May 25, 1966.

Compact "thermoprobe"

A versatile thermoelectric instrument designed by a National Research Council scientist will play an important role in the future design of many types of electrical equipment.

Engineers designing new electrical equipment must know the effect of temperature changes on all interconnected components such as resistors, coils, capacitors and transistors. A temperature variation which adversely affects the operation of a single component or circuit can cause malfunctions in the performance of the over-all system.

Once engineers are able to determine how the component or circuit has been affected by temperature change, steps can be taken to redesign the faulty circuit or replace the component with a superior one.

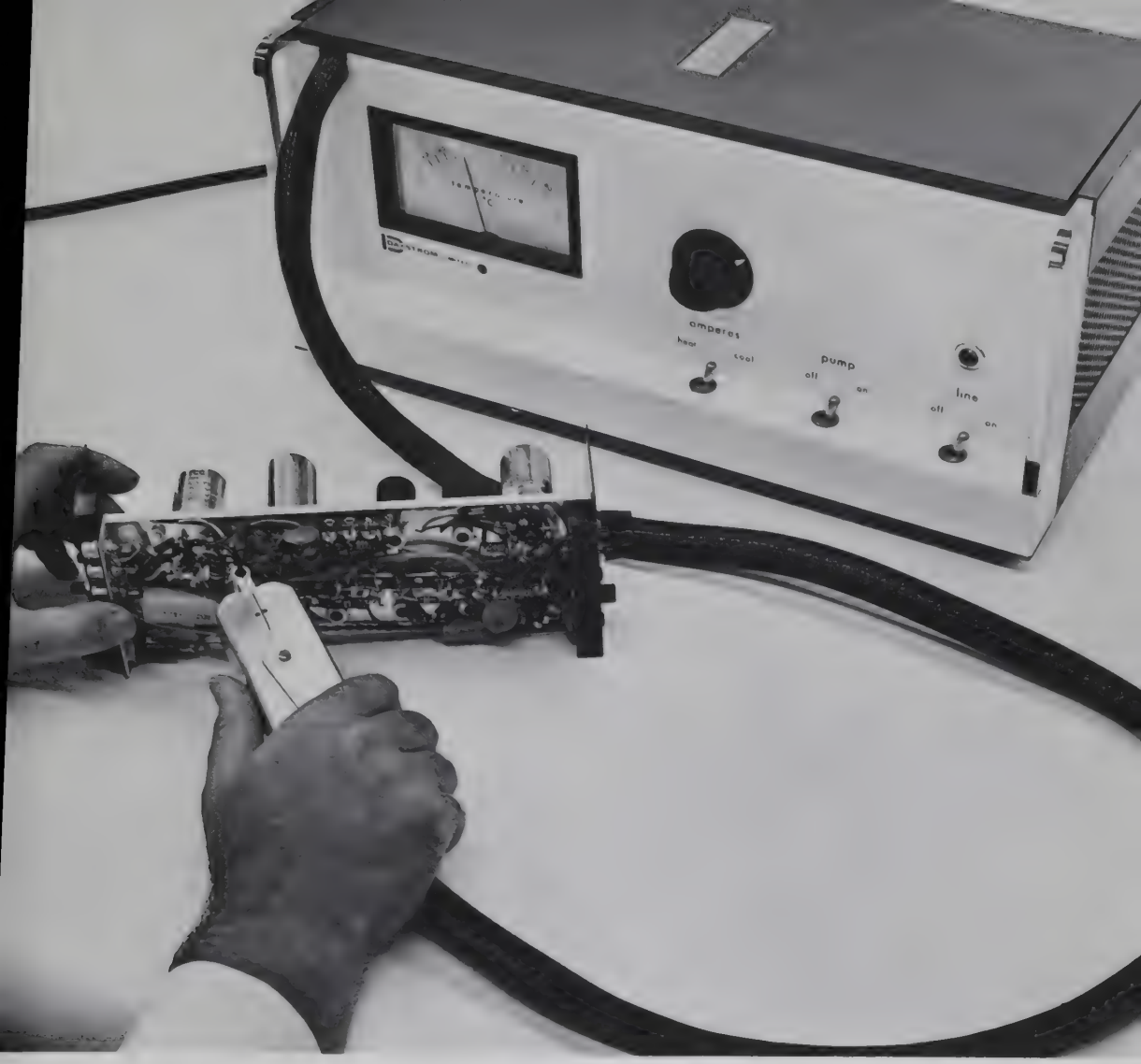
Until recently, the most common method of evaluating the performance and safety of individual components in a circuit was to place the entire piece of equipment in a chamber in which the temperature can be raised or lowered. This is a time-consuming and cumbersome operation and the results do not always give the required information.

The compact NRC instrument, conceived and developed by Dr. David M. Makow when he was with the Radio and Electrical Engineering Division, makes it possible for engineers to obtain a rapid evaluation of the performance characteristics of those parts of the equipment being designed which are most sensitive to temperature changes. Dr. Makow now is a member of NRC's Division of Applied Physics.

The instrument, known as a portable thermoelectric heat pump, now is being manufactured by Daystrom Limited under a licence granted by Canadian Patents and Development Limited, a subsidiary of NRC. It is being marketed under the trade name Weston "thermoprobe."

With the "thermoprobe" engineers can raise the temperature of a single component, such as a transistor, to 70 degrees Centigrade or lower it to minus 20 degrees

Prototype of the thermoelectric heat pump.



The "thermoprobe" being marketed by Daystrom.

with the equipment fully assembled. This latter feature of cooling effectively is the instrument's most important asset.

"It is the ability of the instrument to perform these two functions simply and accurately that make possible a rapid assessment of the effect of temperature changes in individual components on the performance of the whole system," Dr. Makow says.

Another major advantage is that the portable instrument can be used in the laboratory, in a plant or in the field. It thus becomes a valuable tool for prototype design and development work, inspection of incoming components and trouble shooting in field service. Other anticipated uses include chemical laboratory work, medical research, research in biology and biochemistry and inspection of quartz crystals.

The "thermoprobe" consists basically of two thermoelectric elements and a suitable heat sink. By passing a direct current in one direction through these elements, the temperature of special interchangeable fittings which are in contact with them is raised. When the direction of the current is reversed, the temperature is lowered.

These fittings are shaped to enclose the component being cooled or heated. Several types of quick-change fittings are available for use with components of various shapes and sizes. An easy-to-read meter provides temperature readings of the component.

Daystrom is producing the instrument at its Cooksville, Ontario, plant to supply Canada, the United States and Europe.

John A. Baldwin, president of Daystrom, says the "thermoprobe" has found wide acceptance in the United Kingdom and Germany. The Company now is organizing a sales effort in an attempt to achieve similar results in Canada and the United States.

Three-Purpose Instrument

An automatic sea-going instrument to measure depth, temperature and salt content in the ocean has been built by the National Research Council.

The instrument, developed by the Heat and Solid State Physics Section of the Division of Applied Physics, will help fishermen as it can be used to locate concentrations of fish. It also will aid in the use of sonar equipment designed to track submarines and assist oceanographers in their studies in this emerging science.

Temperature - depth - salinity instruments now on the market employ frequency modulation to transmit signals from the submerged measuring head to recording equipment on the deck of a ship. The signals must be converted to direct current.

The circuitry in the NRC instrument, which has been patented by Canadian Patents and Development Limited, a subsidiary of NRC, permits the use of direct current to transmit signals to the recording equipment. This makes the instrument simpler and less expensive than those now on the market.

Dr. T. M. Dauphinee, head of a Section team that developed the instrument, says it measures temperature, depth and salinity simultaneously. These measurements are recorded continuously by "on deck" recording equipment as the measuring head is lowered through the water.

The instrumented measuring head is housed in a brass case which weighs about 60 pounds, and is 3½ feet in length. Designed to withstand great pressures, it can be lowered to a depth of two miles.

A special winch and a cable with a breaking strength of 1,200 pounds are used to lower the measuring head in the water. The cable contains five conductors which transmit temperature, depth and salinity information collected by instruments in the measuring head to "on deck" recording equipment.

The winch is operated electrically. A large dial enables the winch operator to keep a check on the depth of the measuring head, especially when it has reached the surface while being reeled in.

The instrument was used this spring by the Section to study a temperature anomaly in Lake Ontario for the Great Lakes Institute. It will be used again in the fall for studies for the Bedford Institute of Oceanography in Cabot Strait and the Gulf Stream.

The instrument promises to help the fishing industry as fish tend to go where temperature and salinity are right. Oceanographers will find it useful in many studies, including efforts to expand present knowledge of ocean currents. Information obtained with the instrument will help naval ships to make their sonar detecting equipment more effective.

A new salinometer for use in the laboratory also has been developed by the section. This instrument can determine the salt content of sea water to one or two parts per million of salt. It features operational simplicity, low initial cost, and accuracy comparable with the best instruments on the market.

Pilot versions of the two instruments are expected to be on the market in 1967.

New NRC instrument ready to be lowered into the water. Depth dial in foreground.

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Scientific Exchange

The National Research Council of Canada and the Academy of Sciences of the U.S.S.R. have renewed for a further two-year period an agreement for the exchange of eminent scientists and research workers.

The agreement, first negotiated Oct. 28, 1959, was formally concluded by an exchange of letters between Dr. K. F. Tupper, Vice-President (Scientific) of NRC, and Academician Millionshchikov, Vice-President of the Academy of Sciences of the U.S.S.R., in Leningrad, April 28, 1966. The ceremony followed discussions between officials of the Academy, and Dr. Tupper, Dr. W. G. Schneider, Vice-President (Scientific) of NRC, and Dr. J. D. Babbitt, NRC's Secretary for International Relations.

The Council and the Academy during the two years will exchange scientists as follows:

Six eminent scientists from each side for a period in each case up to one month to give lectures, conduct seminars and to become familiar with research and scientific institutions engaged in research in various problems of science. The sending side will propose the names of lecturers and subjects of lectures; if acceptable the receiving side will make all necessary arrangements for the visit.

Fourteen research workers from each side for periods up to nine months for the purpose of conducting research or of acquainting the visiting scientist with current research in his field in the receiving country. The field of specialization in which the scientist intends to work will be agreed between the two bodies in each separate case.

Cover: One of the nine floors of the National Science Library of Canada

Library Report

Miss Bozica Kresic is shown checking in and recording scientific journals and articles received by the National Science Library of Canada at a rate of from 500 to 700 daily.

The establishment of a network of voluntary regional science libraries to insure that everyone in Canada who wants science information gets it quickly has been recommended in a report prepared for the Associate Committee on Scientific Information of the National Research Council.

Strengthening the resources and services of the National Science Library of Canada, a part of NRC, to back up the regional libraries, and the strengthening of university information centres by increased grants specifically for science literature, were also recommended in the report.

Prepared by Professor George S. Bonn, Professor of Library Studies and Head of the Science-Technology Bibliography and Reference Services at the University of Hawaii, the Report suggests that the system should evolve from the NRC's National Science Library to serve the needs of all the scientists, engineers, research workers and graduate students in Canada.

"Ever since the 1958 International Conference on Scientific Information in Washington there has been a growing conviction among responsible bodies of scientists, engineers, and information specialists that science information is a national resource," says Professor Bonn, "and that the development of science information as a national resource is the direct responsibility of the national government. The governments of the U.S.S.R., Great Britain, France and, increasingly, the United States have accepted this responsibility each after its own fashion; but so far Canada has done little about it."

He says that sooner or later some federal agency in Canada will have to assume this responsibility.

To make the National Research Council library in fact, as well as in name the National Science Library of Canada, Professor Bonn says that "it will need additional funds as soon as possible so that it may continue to develop its collections both in depth and in breadth at the same time that it must expand its holdings in areas which it may presently not be emphasizing."

It also will have to enlarge its staff and facilities, if it is to continue to investigate and keep abreast of devices and systems for mechanized service, plan and organize effective national science library and information services, and publicize and announce these services.

In his report, based on a survey conducted in 1965 of science and technology literature resources in 48 Canadian university, public and research libraries, Professor Bonn shows that Canadian scientists and engineers in many fields have to cope with inadequate libraries which "are beset by personnel shortages".

Holdings by individual libraries of scientific journals, "the most essential part and what will probably be the largest part of a research library collection", says Professor Bonn, present "a rather disheartening picture in all too many subject areas, especially in agriculture and technology: the federal government libraries are the only ones with respectable coverage, with one or two minor exceptions."

"Even in physics, chemistry, geology and botany the largest holdings (of periodicals) are in the federal libraries, in spite of the fact that these subject areas are among the most active in terms of university research and graduate study," he continues. "All one can say about the university holdings in technology is that it's no wonder that even undergraduates have to fall back on interlibrary loan for their junior and senior course work."

Some of this material must be borrowed from distant libraries, including those in the United States. Usually university teachers need material within one or two weeks if it is to be useful to them in their lectures. "If material takes longer than a fortnight I no longer need it," a geology professor at Memorial University in Newfoundland told Professor Bonn.

The survey was conducted at the request of the NRC Associate Committee on Scientific Information, whose aim is "to develop a sound policy for scientific information in Canada," according to Dr. J. D. Babbitt, the Chairman, "to ensure that, irrespective of location, every scientist in Canada has access to the scientific literature and the technical information required for his research."

Professor Bonn makes three recommendations to the Committee.

1. The definitive establishment of the National Science Library of the National Research Council as the National Science Library of Canada, to meet the science information needs of scientists, engineers, research workers and graduate students in Canada.

2. The establishment of a network of regional Science-Service libraries in Canada, on a voluntary basis among the most capable publicly-supported libraries. Their purposes would be "to make sure that everyone in

Many research reports are kept on file at the National Science Library of Canada on film cards known as microfiche and microcards. Each four-by-six-inch card contains up to 60 pages of printed material. Copies of the cards are made available on request.

Miss Elvira Hernberger draws a microfiche from a filing cabinet.

Canada has access to technical information, to take some of the burden off the larger research and university libraries in giving service to unattached or off-campus readers, and to encourage inventiveness and technical research interest wherever it might show up," says Professor Bonn.

3. The granting of money along with the grants for research assistants and equipment which are given at present, to purchase literature support for the project in question. This is not done at the present time. These books and periodicals could be added to the library of the institution involved after the completion of the project.

Most of the scientists interviewed by Professor Bonn agreed that the NRC Library should be the National Science Library of Canada. This is logical, he says, because "it was agreed that NRC's library is really quite efficient, if a bit slow at times, it is definitely connected with research and it is now the largest and most comprehensive science library in Canada".

He recommends that it remain in Ottawa, because it is as central as any location in Canada, and that it should have the most comprehensive collection of science literature in Canada, including "little used but important material from world-wide sources not overlooking mainland China, the U.S.S.R., Eastern Europe and the newly developing countries."

Its services should include bibliographic services, referral services to sources of material other than in Canada, photocopying of material borrowed from other libraries and translation services. These would be available at low cost or free to all Canadian scientific personnel.

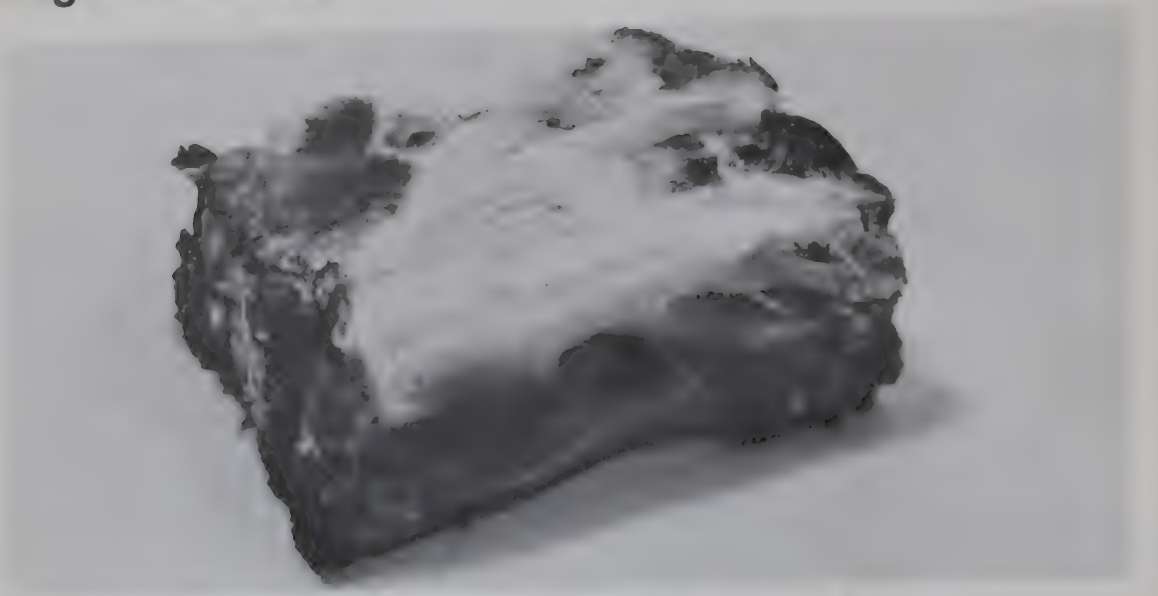
Professor Bonn says "I must say that a great many of these suggested services have been readily available from the NRC National Science Library for a very long time. That Canadian scientists and engineers don't know about them is partly their own fault for not reading the announcements and other published information put out regularly by the National Science Library".

To increase the number of professionally trained librarians, a need which he says is Canada-wide, Professor Bonn suggests that each Canadian university arrange a scholarship for library science training.

At present the University of Saskatchewan has an annual $1,500 bursary for librarians. The National Research Council also recently announced the establishment of a program of ten postgraduate scholarships in Science Librarianship and Documentation to Canadian students per year. Six were granted in August, 1966.

The microfiche is placed in a microfiche reader (left) and printed material is enlarged and projected on the reader's illuminated screen where it can be read by scientists. The page on the screen also can be photocopied.

Vegetable Study



Frost and ice crystal build-up in frozen broccoli caused by sublimation.

A National Research Council study indicates that serious dehydration, apparently caused by temperature fluctuations during storage, transport and retailing, occurs in packaged frozen vegetables, and is accompanied by quality deterioration.

The study, conducted by the Food Technology Section of the Division of Biosciences, involved the examination of 66 packages of frozen vegetables from eight Ottawa stores. It showed that there was a progressive accumulation of frost inside the package from the time they were frozen until they were bought for the study.

The frost or ice crystals which formed inside the packages represented water removed by the physical process known as sublimation. During this process, ice inside the vegetables vaporises and in turn condenses as frost. Temperature fluctuations are thought to be mainly responsible for this accumulation.

"The results of this study indicate that serious loss of quality of frozen vegetables results from in-package desiccation," says Bert van den Berg of the Food Technology Section. "This process of desiccation (dehydration) apparently progresses during freezing, storage, transportation and retailing, and is accelerated by temperature fluctuations."

Mr. van den Berg says the study justifies further research to find methods of minimizing the amount of frost build-up in frozen vegetables after they leave the processing plant.

A constant storage temperature of zero degrees Fahrenheit is regarded as acceptable for storing frozen vegetables up to one year. However, wide temperature variations are known to occur in transport trailers and in retail frozen-food cabinets.

The transport trailer problem could be solved by a jacketed or double-wall type of cooling system in which cold air is circulated through a jacket or space entirely surrounding the load rather than through the space above the load only, as in most conventional refrigerated trailers This jacketed system, similar to one developed by NRC for the storage of fresh vegetables, ensures zero-degree temperatures for frozen food during transport.

The 66 packages of frozen food studied by Mr. van den Berg consisted of peas, cut beans, mixed peas and carrots, vegetable mix for stews, brussels sprouts and broccoli. Seven major brands and three store name brands were represented.

Purchases were made both early and late in the week to obtain samples before and after restocking of retail cabinets. Samples were selected from cabinets that appeared to be operating normally, were not overloaded and did not, as far as could be determined, contain partially or completely thawed packages. They were selected at random except in a few instances where some were taken from top and bottom layers to determine whether location in the cabinet was a factor. Samples were transported

directly to the laboratory in an insulated container and held at zero degrees Fahrenheit.

Working in a chamber held at zero degrees Fahrenheit, Mr. van den Berg separated accumulated frost from the vegetables. The vegetables were packaged in wax cartons with a wax paper overwrap and plastic bags.

Eighty per cent of the samples had an appreciable frost content (over two per cent), while 14 per cent contained an excessive amount of frost (over eight per cent). Analysis of the results did not reveal differences due to grade, stores, chains, brands, time of sampling or location in the food cabinet. However, there was a smaller proportion of frost in wax cartons as compared with plastic bags.

Clumping and discoloration (freezer burn) were commoner as the amount of frost increased. In extreme cases of dehydration shrivelling had occurred in peas, and beans had a brown discoloration.

Thawing and cooking peas disclosed that changes caused by desiccation are largely irreversible. The average weight of cooked pea samples with little frost accumulation was 96 per cent of the weight printed on the label, while that of packages with four to eight per cent frost was 92 per cent.

Changes in odor and flavor of cooked peas were noticeable at frost levels of about four per cent and were increasingly apparent at higher levels of desiccation.

High Award

Dr. Rose

Dr. Dyson Rose of the National Research Council of Canada has become the first Canadian to receive the American Chemical Society Award in the Chemistry of Milk.

Announcement of Dr. Rose's selection as 1967 recipient of the award was made in New York City Monday, September 12, at the 152nd National Meeting of the American Chemical Society. Dr. Rose, 50-year-old head of the food Chemistry Section of NRC's Division of Biosciences, will receive the award at the 1967 spring meeting of the Society at Miami Beach Monday, April 10, 1967.

The award, sponsored by the Borden Company Foundation Inc., was created in 1939 to recognize and encourage outstanding research achievements in the chemistry of milk in the United States and Canada. It consists of $1,000 and a gold medal.

The award recognizes research conducted during the last 15 years by Dr. Rose and his Dairy Chemistry Group. Other members of the group include Dr. M. A. Boulet, Dr. J. M. Neelin, H. Tessier and J. R. Marier.

Throughout the many years that man has used milk and milk products as food, he has learned to preserve some of its nutritive value in the form of cheeses and of fatty products. However, his ability to preserve milk in its natural beverage form has always been, and continues to be, very limited.

Dr. Rose's group has made a number of important contributions in the preservation of milk in its natural state. In one area it has defined the composition and properties of caseinate particles in milk more closely so that their behavior during the processing of milk and milk products can be better understood and so that undesirable changes can be predicted and avoided.

Dr. Rose, a native of Delia, Alberta, joined the National Research Council in July, 1942. He was appointed Head of the Food Chemistry Section of the Division of Biosciences in 1950.

Dr. Rose is the author of more than 60 scientific papers, about half of which deal with milk or the chemistry of milk constituents.

A National Research Council study group has urged the Canadian government to establish a National Motor Vehicle Accident Research Centre to find ways to reduce the number and seriousness of accidents on Canadian roads and highways.

The recommendation was made to the Council by a Motor Vehicle Accident Study Group set up five months ago by NRC's National Aeronautical Establishment. NAE became involved in motor vehicle accident research as a natural extension of its 25 years of experience in aircraft development, including accident research.

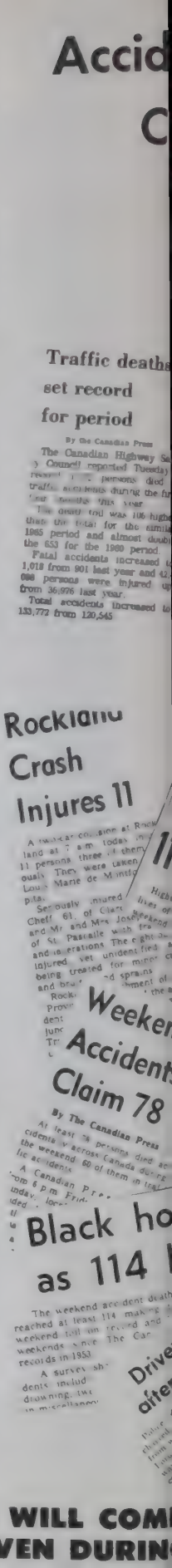
The Study Group made its recommendation after conducting a comprehensive study of existing technical literature relating to motor vehicle accidents. Members of the group held discussions with most provincial government authorities, Canadian safety organizations, automobile manufacturers, a number of United States safety organizations and certain European and international agencies concerned with the motor vehicle accident problem.

The NAE Study Group found that there is little Canadian research on the prevention of road accidents and that what is being done is fragmented and unco-ordinated.

"There is a need for a central body in Ottawa to co-ordinate safety research throughout the country and to represent Canada in this field in international circles," the group said. "Such an impartial body would be in a position to ensure that motor vehicles built in, or imported into this country, comply with Canadian engineering and safety standards and could advise the Canadian government on motor vehicle safety at the research level."

The Study Group's main report said a "strong case" can be made for a major Federal Government involvement in all areas of road safety. It said there can be little hope of even a partial solution of the road safety problem in the absence of such leadership and involvement.

The responsibilities of the proposed research centre would be to provide for the benefit and use of federal, provincial and municipal agencies technical information and the research and test results required to establish federal motor vehicle specifications and standards, national codes of practice and regulations relating to road-worthiness. It also would maintain a continuing technical relationship with all levels of government and with foreign safety organizations



DEATH WILL COM
EVEN DURIN

and stimulate and co-ordinate research on road safety by other organizations in Canada.

The centre initially would conduct research into the determination of accident causes, the prevention of accidents and the prevention of injuries caused by accidents.

Determination of Accident Causes:

1. Analysis of country-wide road accident statistics.
2. Detailed scientific studies of the character of accidents.
3. Development of a better understanding of the driving task through studies of the ability of the mind and body to perform this function.

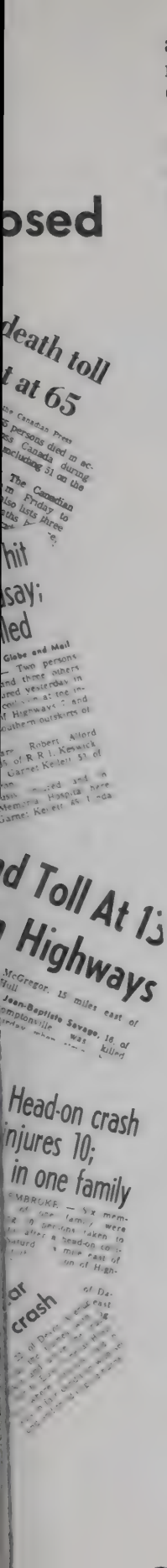
Prevention of Accidents:

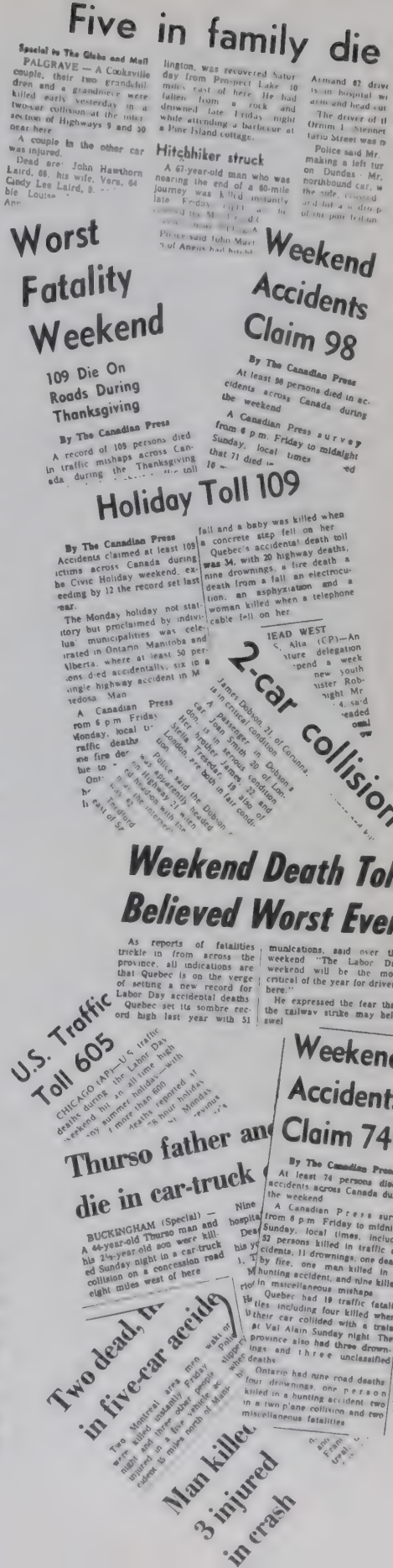
1. Investigation of a possible correlation of road accidents with "acceleration noise". (Undesirable changes in speed or direction.)
2. Studies of the effect on accidents of intersection design, including the control of traffic lights and the characteristics of road surfaces.
3. Application of an improved understanding of the driver task to new driver training procedures.
4. Study of the feasibility of improved communication—car-to-car and road-system-to-car. This would include such things as better signals to enable a driver to know what another driver plans to do and better traffic signs and signals of all types.
5. Development of optical systems for improved driver vision.
6. Improvement of braking on icy roads.
7. Study of automobile handling characteristics.

Prevention of Injuries Caused by Accidents:

1. Improvement of the impact resistance of safety glass.
2. Investigation of the use of electrical heating of safety glass.
3. Study of the physiological effects of rate of deceleration (known as "jerk").
4. Feasibility and experimental study of rearward-facing passenger seats.

The Study Group said that there is no single solution to this difficult and complex problem. Its study of the literature shows that the driver is the main cause of accidents. Engineering deficiencies of the vehicle and the road also contribute but to an undetermined and definitely secondary degree. However, there appears to be considerable scope for the reduction of death and injury by correcting these deficiencies.





Acoustic Test Laboratory

Dr. Lindberg is shown measuring sound level where the exponential propagation horn joins the progressive wave tube.

Noise loud enough to be fatal to an unprotected observer is being generated at the National Research Council to make aircraft and aerospace vehicles of the future safer and better.

The high intensity noise is being produced in a new Acoustic Test Laboratory which has been built at NRC's National Aeronautical Establishment near Ottawa's Uplands Airport. It is Canada's first major test facility for studying at the design stage the effects of noise on all the structural and other components that go into the construction of modern aircraft.

In the past designers of complicated aerospace vehicles have had to wait until the development and testing of the prototype to discover that they have a problem of acoustic fatigue.

The acoustic laboratory will enable scientists to conduct a wide variety of tests to determine the life of various structures, such as metal panels for fuselages, and wings and tail assemblies, when they are subjected to the high intensity noise fields produced by jet aircraft engines and high speed flight. Scientists also will be able to study the processes by which acoustical energy can set up vibrations in a structure causing structural damage.

The future of high speed flight depends in large measure on the ability of scientists to develop structural components which will withstand intense noise fields. One main problem will be to achieve greater fatigue resistance for more severe noise loadings, while simultaneously reducing the weight of components.

Dr. G. M. Lindberg, head of the $125,000 laboratory, says that requests now have been received from several aircraft firms in Canada to use the laboratory for research development work.

The new laboratory at present is equipped with two intense noise generators, driven by air supplied from the air storage bottles of the NAE supersonic blowdown wind tunnel. The generators are known as a discrete frequency siren and a random noise siren, which are used separately in tests.

The discrete frequency siren, which generates noise at a single frequency, can be tuned into resonance with aircraft panels for panel response or fatigue tests.

Dr. Lindberg and technician John Woolley attach strain gauges to test panels of sheet metal to be subjected to high intensity noise.

The random siren generates a broad band noise similar to jet engine noise. Sound pressure levels vary from 140 decibels (db) to 165 db. A trained vocalist singing loudly three feet away exerts a pressure upon the ear of about 70 db. The ear feels pain at 130 db, and a level of 165 db can be fatal.

Sound travels from the sirens through a horn arrangement to a device called a progressive wave tube. A progressive or plane wave is one which is allowed to propagate freely and is not reflected. This tube is eight feet long and has a cross section one by four feet.

The side panels of the tube can be removed and replaced by a panel of any metal which is to be tested for its response when subjected to varying conditions of sound pressure, and to determine its life under conditions of acoustically-induced stress.

Strain gauges are attached to the test panel at points of peak stresses to measure the magnitudes of stress. The strain gauge signals are amplified and recorded for detailed analysis.

The sound then propagates through another horn to a reverberation room and then to an anechoic (sound-deadening) termination room where it is absorbed and dissipated by panels of polyurethane foam. The termination room stops reflection of the sound back to the reverberation room which would create interference.

This arrangement simulates free space conditions in the reverberation room. It is as if the sound generator were pointed straight up in the open air.

The reverberation chamber, which is 15 feet by 15 feet by 10 feet high, is constructed so that an intense diffuse (uniform) sound field is created. At all points in the room sound levels are the same.

A large concrete plug at the far end of the room can be removed to connect it with the termination chamber. With this plug in place, electronic equipment packages can be suspended in the reverberation room and subjected to intense noise to satisfy environmental testing requirements.

The sound-diminishing qualities of a substance can be tested by removing the concrete plug. Test panels are placed in the concrete plug opening and the sirens are used to generate intense noise in the reverberation room. The noise-attenuating (reducing) qualities of the panel can be found by measuring the difference in sound levels in the two chambers with microphones. A typical example of one of these sound transmission loss studies would be to examine a test panel from the body of a jet aircraft to determine whether it will reduce the noise level within the cabin below the tolerance level.

Stellar Dust Study

A unique new National Research Council instrument is expected to help space scientists learn more about the tons of stellar dust which enter the earth's atmosphere every day.

The instrument—an acoustic micrometeoroid detector—was developed by the Upper Atmosphere Research Section of NRC's Radio and Electrical Engineering Division. It forms part of the scientific payload contained in the nose cones of rockets being fired to altitudes of up to 120 miles to study the earth's atmosphere.

Micrometeoroids from outer space are so small that they are not destroyed by friction on entering the earth's atmosphere. It's estimated that up to 10,000 tons a day settle to the earth's surface.

Scientists began studying micrometeoroids by collecting them from land sediments and sea deposits. However, for the last few years, rockets have permitted the study of micrometeoroids while they are still in the earth's atmosphere.

The new detector, developed by Romeo Wlochowicz of the Upper Atmosphere Research Section, is a small instrument which can be installed easily in research rockets being launched at NRC's Churchill Research Range at Churchill, Manitoba, or elsewhere in the world.

Mr. Wlochowicz calibrates a micrometeoroid detector

The detector is mounted inside the rocket nose cone, with a sensing device in the shape of a three-inch diameter disc forming part of the shell of the nose cone. At launch-off, the disc is covered with a shield which is released at a predetermined height, exposing the disc to micrometeoroid bombardment.

Micrometeoroids strike the disc at a velocity of about seven miles a second or even higher speeds. Each impact creates a high-frequency sound which is picked up by a small microphone attached directly to the sensitive surface of the detector. Electronic equipment in the detector transmits the sound generated by each impact to recording equipment on earth for later analysis. The sound generated by each impact depends on the size of the particle and the speed at which it strikes the detector.

"The analysis of records from micrometeoroid studies in 1963 and 1964 implied the existence of an unexpectedly large proportion of the smaller micrometeoroids," Mr. Wlochowicz says. "In these studies micrometeoroids were detected at altitudes of up to 120 miles, using the nose cone of the rocket as the sensing surface. However, it was difficult to distinguish sound waves generated by micrometeoroid impacts from the noise of the rocket in its high-speed flight."

The new instrument has been designed to eliminate this kind of interference. This has been accomplished by isolating the instrument acoustically from the rocket by a plastic foam shield.

"We expect that this special feature of the instrument will aid us in obtaining more information about the distribution of micrometeoroids in the atmosphere," Mr. Wlochowicz says.

The new micrometeoroid detecting system can also be equipped with a shutter arrangement in rocket shots where the nose cone is to be recovered after its flight in space. After the nose cone begins its descent to earth, the shutter mechanism automatically covers the exposed detecting surface. When the nose cone has been recovered, the minute craters formed by micrometeoroid impacts can be examined visually. This information then can be correlated with the data radioed to earth during the flight.

New Laboratory

Financial aid provided by the National Research Council has led to the establishment of Canada's first industrial research laboratory for the study of the basic chemistry of organic and inorganic tin compounds.

The organization of the new research laboratory by M&T Products of Canada Limited also resulted in the company doubling the size of its Hamilton, Ontario, plant.

M&T Products, operator of the only tin recovery plant in Canada, is a major Canadian manufacturer of plating chemicals, industrial coatings, organotin products, cleaning and buffing compounds and related chemical products. It recovers tin from tinplate scrap for the manufacture of potassium and sodium stannates used to coat automotive pistons and makes proprietary tinned chemicals used to electroplate aluminum.

On July 17, 1964, the company applied for financial aid under NRC's Industrial Research Assistance Program to help it establish a full-scale research laboratory. The company's application for aid was approved about two weeks later, and an initial grant of $27,000 was authorized for the 1964-65 fiscal year.

By the following November, the company came to the conclusion that the potential increased production likely to be stimulated by research warranted increased production facilities. As a result of this decision, the company decided to build not only the laboratory but a 17,000 square foot plant addition at a total cost of $500,000.

Funds provided under the I.R.A. program directed by the NRC Committee on Industrial Research Assistance, and administered by NRC's Technical Information Service, are used primarily for paying the salaries of new research teams in companies where none previously existed, or for new research workers to be added to existing research staffs over and above a company's normal expansion of research effort. M&T Products received $43,500 in 1965-66, $41,300 in 1966-67 and is eligible for grants for two additional years.

R. D. Fraser, vice-president and general manager of M&T Products, says NRC's I.R.A. program was the "motivating force behind our decision to double plant facilities." He says the laboratory is the only industrial one of its type in Canada devoted entirely to the study of the chemistry of tin to satisfy Canadian needs.

A section of the new research facility at M&T Products of Canada Ltd.

"It has already developed new knowledge of value, and it is hoped that new markets and uses for existing organic and inorganic tin chemicals, or new chemicals, will be developed," he says.

The company decided to build the laboratory because Canadian industry needs its own research facilities to fully realize its marketing and productive potentials.

"Research is a key element in the application of the marketing concept in which all of the manufacturer's operation must be attuned to the needs and desires of the market and the consuming public," Mr. Fraser says.

A unique feature of the operation is that 13 members of the University of Toronto's Department of Chemical Engineering and Applied Chemistry are associated with the M&T Products research program. The professors, members of Chemical Engineering Research Consultants Limited, assisted the company in establishing a research program and in staffing the laboratory.

R. E. McBurney, secretary of the I.R.A. Committee, says this arrangement has established a feedback from industry to university which the latter has welcomed as contributing to future understanding between industry and the universities.

Predicting Avalanches

A new technique developed by the National Research Council will improve the reliability of equipment used to determine when avalanches are likely to strike in remote mountain areas, such as sections of the Trans-Canada Highway in the Rocky Mountains.

One of the key factors in predicting avalanches is reliable wind information. This must be transmitted automatically by radio from unattended weather stations high in the mountains to manned stations at lower altitudes.

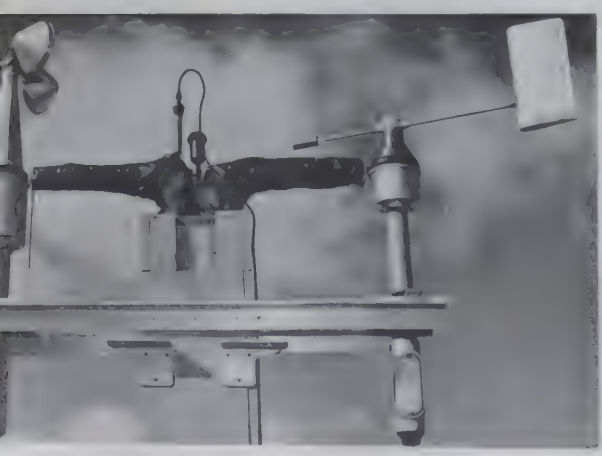
Wind information is collected at the unmanned stations by two instruments—an anemometer which measures wind speed and a wind vane which measures direction. Both instruments are mounted on a mast on the unmanned weather station.

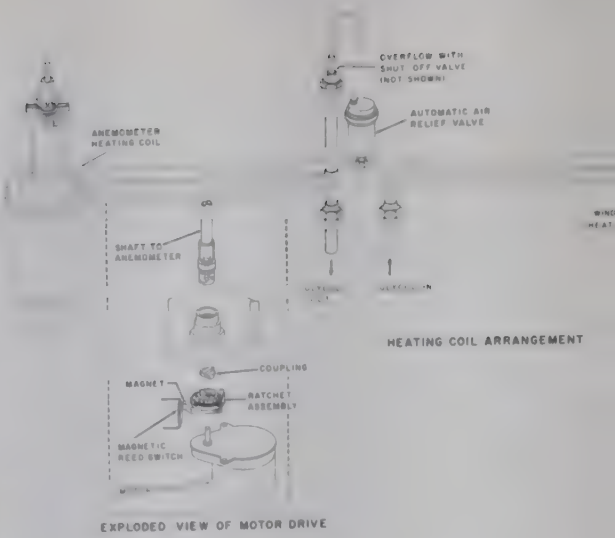
The anemometer consists of three small metal cups which rotate on a shaft covered with a conical housing. The wind vane, which resembles a simple ship rudder, also rotates on a shaft.

If icing conditions are not present the two instruments rotate freely, measuring wind speed and direction and feeding this information to equipment located in the weather station. The information then is relayed by radio to the manned weather station at a lower altitude.

However, sleet and freezing rain storms can bring the entire remote control system to a halt. Ice forming at the rotating joint of each instrument prevents them from rotating.

Anemometer (left) and wind vane in operation at NRC.





This problem has been solved by a de-icing system developed jointly by George Neal, J. C. Barnes, and R. A. Wright of the Navigational Aids section of NRC's Radio and Electrical Engineering Division.

An electronically controlled propane heater located in the unmanned weather station is used during periods of icing to heat a solution of ethylene glycol and water to a temperature of approximately 150 degrees Fahrenheit. This hot solution flows by convection through insulated copper pipes to a pair of copper rings encircling the rotating joints of the anemometer and the wind vane, and melts any accumulated ice.

A unique detector is used to determine when icing has taken place and to ignite the propane burner, and start the flow of the ethylene-glycol solution to the copper rings on both instruments.

A small electric motor is coupled by a specially designed clutch to the shaft on which the anemometer rotates. Power is supplied automatically to the motor from the batteries in the weather station every 20 minutes for a period of one minute. If the anemometer cups are not iced and free to rotate, the motor completes one revolution in less than a minute and shuts off automatically.

However, if the motor cannot turn the anemometer cups, the propane burner switches on, putting the de-icing system into operation. The burner remains ignited until the first regular command period in which the cups are free to turn in less than one minute. A ratchet assembly permits the cups to rotate freely without "drag" from the motor during normal operation.

The system, because it operates only when necessary, conserves the battery power used to ignite the heater and to drive the motor in the ice-detection system, and also the propane fuel used by the heater. This is essential because the stations must remain unattended for seven months of the year.

The new de-icing method has made a major improvement to equipment developed by NRC for transmitting weather information automatically from unattended stations in high mountain passes to manned stations at lower altitudes. Besides wind information, this equipment also transmits information about the air temperature.

Snow physicists can use this information along with data on snow depths in a particular area to predict when avalanches are likely to occur. Trench mortar crews can then be sent to trigger an avalanche prematurely or to close the mountain road to traffic until the danger has passed.

NRC At Expo 67

The National Research Council of Canada will sponsor a program of outstanding films on science from some 70 countries at Expo 67, the 1967 Universal and International Exhibition to be held in Montreal. Entitled "Insight 67," the program will be staged in the DuPont of Canada Auditorium during the 26 weeks of the Exhibition, which opens April 28, 1967, and closes October 27.

"Insight 67" will be one of three scientific programs which will take place in the 372-seat auditorium, built by DuPont at a cost of about $375,000. The two other programs will be a series of 27 lectures by world famous scientists and scholars, including Nobel Laureates, and 26 Junior Science Lectures and Demonstrations.

The program of science films is being organized for NRC by the National Science Film Library, which is supported financially by the Council. The National Science Film Library is an agency of the Canadian Film Institute.

The Council will spend $50,000 to cover the cost of the program and the collection of film prints from around the world. The collection will include research films for scientists, films designed to help students plan a career in science and films of broad appeal for the layman.

Three hours of films will be shown every day during the entire 183 days of Expo 67.

The series of 27 lectures is being sponsored by Noranda Mines Limited at a cost of $100,000. This money will cover the cost of honoraria for the lecturers, their transportation and local expenses, simultaneous translations, printing and other miscellaneous costs.

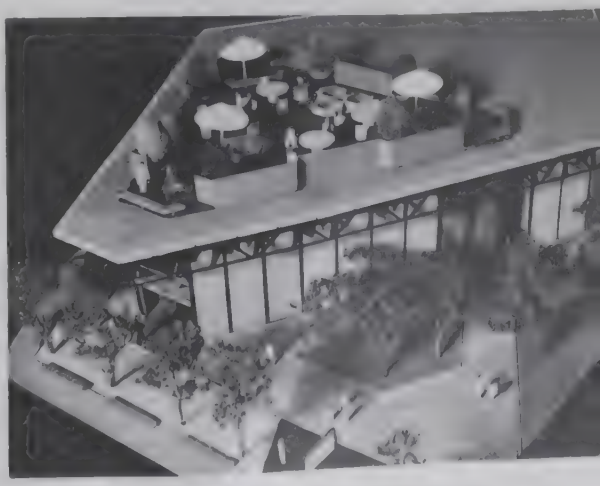
The lectures will cover not only the pure and applied sciences, but also the humanities and the social and political sciences. As far as possible, the lectures will be delivered before specially invited audiences every Monday at 5 p.m. throughout the period of the exhibition.

The 26 Junior Science Lectures and Demonstrations will be staged each Saturday at 1 p.m. during the Exhibition. These lectures will be directed towards scientifically-oriented high school and junior college students.

NRC is sponsoring the lectures at a cost of $25,000. This money will cover honoraria for the lecturers, their travel expenses, the cost of building demonstration equipment, printing and other related costs.

The lectures are being arranged on behalf of the Council by the Chemical Institute of Canada.

Model of DuPont of Canada Auditorium.



Arctic Rockets

Two historic rocket shots to study cosmic X-rays which have not been contaminated by energetic particles trapped in the Van Allen radiation belt have been fired successfully from a special launch site at Resolute on Cornwallis Island in the Canadian Arctic.

The rockets, first large ones ever to be fired in the Arctic, were launched Monday, July 18, and Wednesday, July 20, 1966, under the direction of Philip Markham of the Space Research Facilities Branch of the National Research Council.

All experiments aboard the rockets performed successfully and studies of signals received by ground-based telemetery equipment disclosed interesting and valuable information. The studies also indicate that further experiments should be flown in this critical region near the North Magnetic Pole.

The special launcher, the rockets and all equipment were flown to Resolute in the Northwest Territories from Winnipeg. All equipment was tested out in Winnipeg at Bristol Aerospace Ltd., manufacturer of the Black Brant rockets.

The nose cone of the Canadian Black Brant III research rockets carried a special detector system for measuring cosmic X-rays. It was developed by Dr. Brian Wilson of the Space Physics Laboratory of the University of Calgary.

The rockets also carried plasma probes designed by Dr. A. G. McNamara of the Upper Atmospheric Research section of NRC's Radio and Electrical Engineering Division.

X-rays from sources external to the solar system may be produced by specific sources such as certain stars and the intense magnetic fields which are known to exist around super-novas—stars which have exploded.

Measurement of cosmic X-rays is difficult because they are contaminated by radiation in the earth's magnetic field, especially by the Van Allen belt. This is a region of radiation, produced by the sun, which is trapped in the earth's magnetic field and produces its own X-rays.

Resolute, 1,665 miles north of Winnipeg, was chosen as the site for the two rocket launchings, because the effect of the earth's magnetic field and of the Van Allen belt are at a minimum at this point. This makes it possible to study cosmic X-rays which have not been interfered with by the earth's magnetic field and the Van Allen belt.

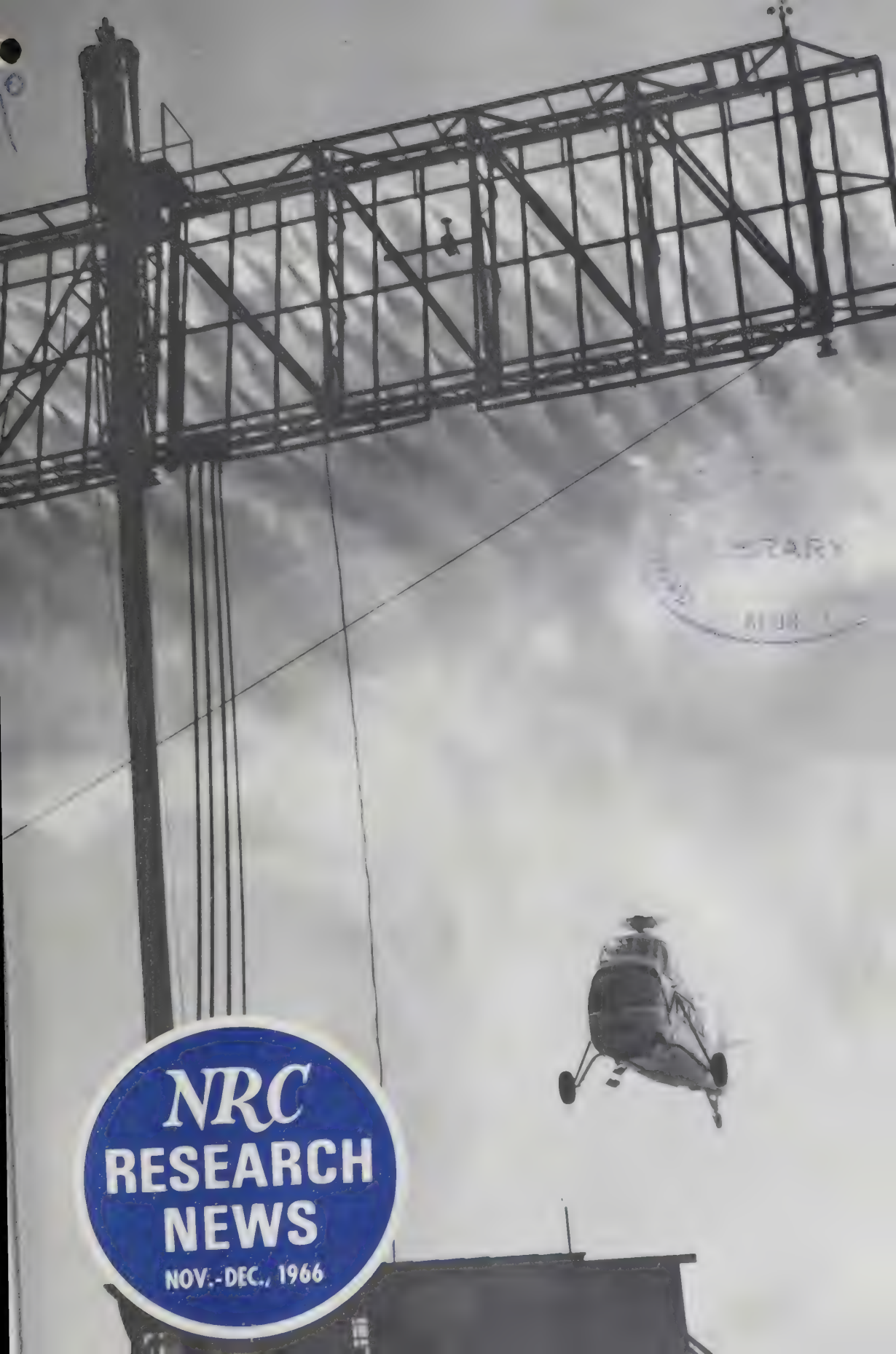
Rocket measurement of cosmic X-rays is a relatively new technique. Three experiments of this type have been carried out in the United States and last March a similar experiment was conducted by the University of Calgary with the co-operation of NRC at the Churchill Research Range at Churchill, Manitoba.

The first of two rockets fired at Resolute rises from its launcher.

Resolute also was selected over other places near the North Magnetic Pole because of facilities operated there by the Department of Transport, including weather forecasting, an airfield and electric power.

The two rockets carried their payloads of about 55 pounds to a height of some 100 miles. This height is considered adequate for the measurement of uncontaminated cosmic X-rays.

Studies of cosmic X-rays may help to determine how the universe was formed and whether it is expanding or contracting. These X-rays are believed to have some bearing on the origin of the universe and their strong, large energy outputs have sparked great interest among scientists.



NRC RESEARCH NEWS

NOV.-DEC., 1966

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Cover: NRC's spray rig to study icing on helicopters in flight.

Photo Credits: Dr. W. G. Schneider by Paul Horsdal; others by NRC.

Thermonuclear Reactions

Bright light (centre) is from plasma heated to over one million degrees in the experiment with the capacitor bank. The capacitor bank is in the background.

Temperatures higher than those in the sun's corona are being created at the National Research Council in studies of thermonuclear reactions.

Scientists in the Laser and Plasma Physics Section of the Division of Pure Physics have created a plasma (a gas in which electrons have been stripped from the atoms) with a temperature of over one million degrees centigrade.

This is hot enough for thermonuclear fusion to take place. However, experiments so far have only attained such temperatures for millionths of a second. Before scientists can develop reactors to tap the great potential of fusion as a source of heat to produce electrical power, they must learn to develop and sustain such high temperatures.

Canada has played a leading role in developing a way to measure the temperature of the ions (particles) in the plasma to produce the most direct evidence so far of the existence of a thermonuclear reaction in a laboratory plasma.

Thermonuclear fusion, the union of the nuclei of light atoms such as deuterium (a variety of hydrogen with an atomic mass of 2) at very high temperatures, will enable man to use sea water as a fuel supply, because of the presence of deuterium in sea water.

As the nuclei unite they release neutrons. The nuclei of two atoms of deuterium, for example, fuse to become a helium 3 nucleus, releasing one neutron in the process. A great deal of energy is released in the fusion reactions between these atoms, most of which appears as kinetic (1) energy carried by the fast-moving neutrons.

Slowing neutrons in a moderating substance such as water outside the reaction chamber could harness this energy to generate steam to run a steam turbine.

Nuclear fusion, unlike fission, does not require radioactive elements and is therefore a "clean" reaction.

Evidence for the existence of a thermonuclear reaction in a laboratory has been found in an experiment in which a bank of capacitors, charged to a voltage of 20,000 volts, discharges 100,000 joules (2) of electrical energy through a single-turn coil surrounding a quartz tube filled with deuterium gas at very low pressure. The energy is discharged in only a few millionths of a second and produces a current higher than one million amperes around the coil for a few

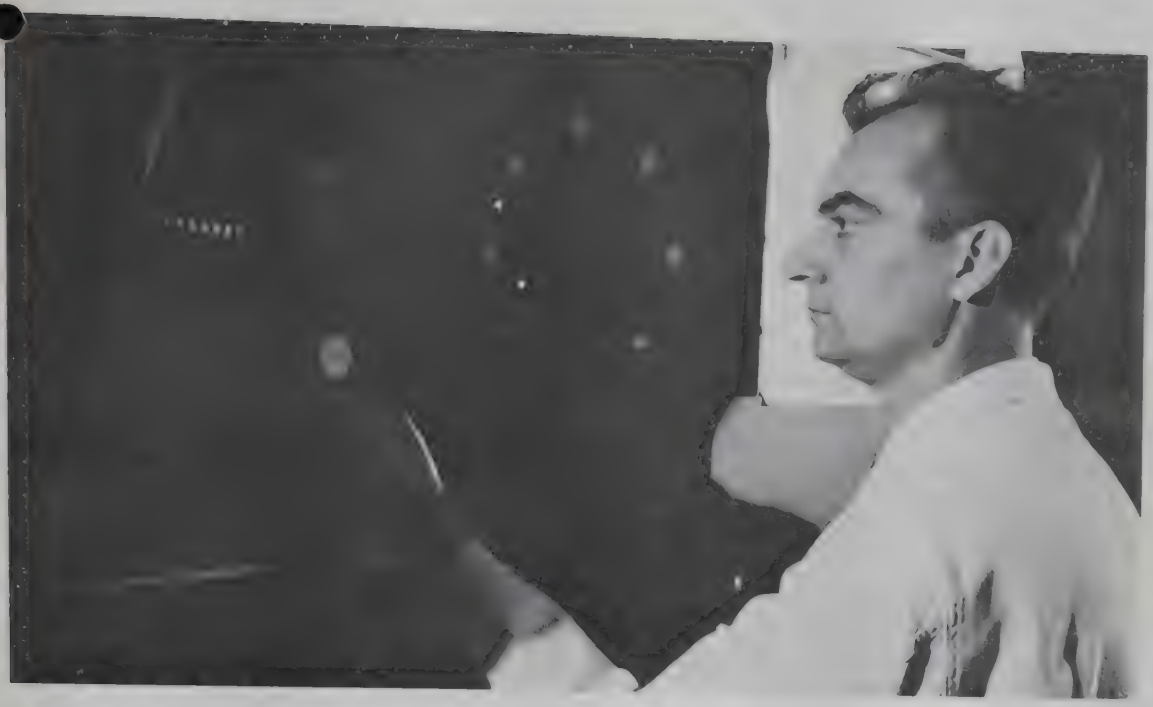
Streak photograph of the plasma taken through a slit at the centre of the coil.

microseconds. This produces a powerful magnetic field around the tube which ionizes the gas, producing a plasma with a temperature of over one million degrees. The plasma emits soft X-rays and neutrons.

NRC scientists have in this experiment obtained a plasma hot enough for thermonuclear reactions to be possible, and they have observed neutron emission from the plasma. Preliminary results of the measurement of the ion temperature in the plasma indicate that these neutrons are indeed thermonuclear in origin and not just from acceleration of ions in the discharge, reports Dr. S. A. Ramsden, head of the Laser and Plasma Physics Section.

The highly complicated technique used for this measurement of ion temperature, developed by members of the Section, is being adopted by large thermonuclear estab-

Dr. de Michelis assembles equipment used in the experiment in which a laser pulse evaporates lithium hydride and heats the vapor to over one million degrees.



Ray Benesch of the Laser and Plasma Physics Section examines the nest of convex mirrors which direct scattered light waves from the laser beam onto photomultipliers.

lishments throughout the world, including Germany, Britain, the U.S.A. and the U.S.S.R.

In the technique a high-intensity laser beam is directed through the plasma in the quartz tube. A very small amount of the laser light is scattered by the electrons in the plasma, just as a small fraction of a beam of sunlight is scattered by dust particles in a room.

Evidence that the plasma is hot enough for thermonuclear fusion to take place has been obtained by studying the scattering of the laser beam as it passes through the plasma. Measurement of this scattered light is extremely difficult because only one billion-billionth of the laser beam is scattered. The rest goes directly through and is "dumped" as it leaves the discharge tube.

The scattered light waves from the laser beam are directed by a nest of convex mirrors onto photomultipliers which magnify these weak signals one million times so they can be observed on a number of oscilloscopes.

In two other experiments the Section is studying hot plasmas produced with the use of a laser beam alone.

In the first, directed by Dr. A. J. Alcock, a 100-megawatt ruby laser is focussed with a short focal length lens in air or other gases. Where the beam converges it produces a spark which is similar to an electrical spark in that it creates noise and a flash. The spark occurs as the laser beam ionizes the air to form a plasma. Interferometric studies and measurement of the X-rays produced show that the spark is heated to over one million degrees, although only for a nanosecond (one billionth of a second).

In the second experiment a means of filling a chamber with a hot plasma, in which a thermonuclear reaction could take place, is being investigated by Dr. Claudio de Michelis, an NRC post-doctorate fellow from Rome. The method is to focus the high-power laser onto a solid particle of lithium hydride. Lithium is also a fairly light atom. The particle is about 50 microns (50 one-thousandths of a millimeter) in diameter, and is suspended in a vacuum by means of six electrodes which form a cube and subject the particle to electromagnetic forces from all sides. The laser pulse evaporates the lithium hydride and then heats the vapor to over one million degrees. The characteristics of this hot plasma, like the others, are studied by means of high-speed photography and measurement of X-ray emission.

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(1) Kinetic energy: the energy which a body possesses by virtue of its motion.

(2) Joule: the work done in a second by a current of one ampere flowing through a resistance of one ohm.

Brain Scanner

Encouraging results have been obtained with a new brain scanner built by the National Research Council for the diagnosis of brain disorders by ultrasonics.

The scanner, under development by Dr. David Makow of NRC's Division of Applied Physics, Photogrammetric Research Section, was evaluated at the Montreal Neurological Institute during the examination of 26 persons suffering from various types of brain disorders, such as tumors, strokes, hydrocephalus and dementia.

The examinations, conducted in collaboration with Dr. D. L. McRae, Radiologist-in-Chief of the Institute, showed that the new scanner is a major improvement over the system used the year before.

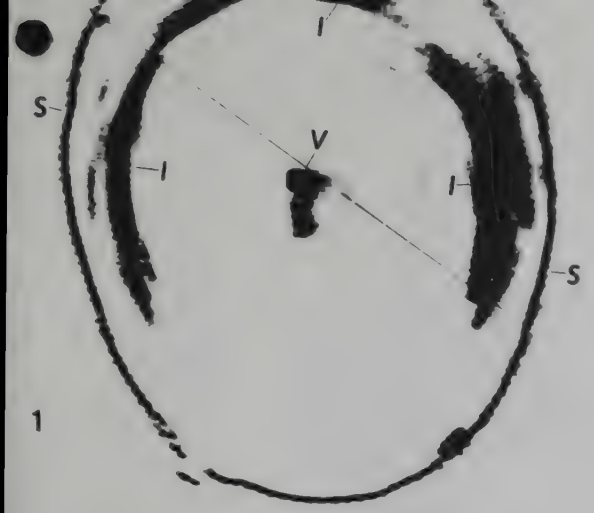
At present two X-ray methods are used to obtain information on the size, shape and position of intracranial structures. The cerebral fluid has to be drained from the spaces inside the brain (the brain ventricles) and replaced by air, or a radio-opaque substance has to be injected into the blood vessels of the brain. Both methods are operative procedures and are complicated.

The ultrasonic method is simple and painless and may eliminate X-rays in a considerable number of cases.

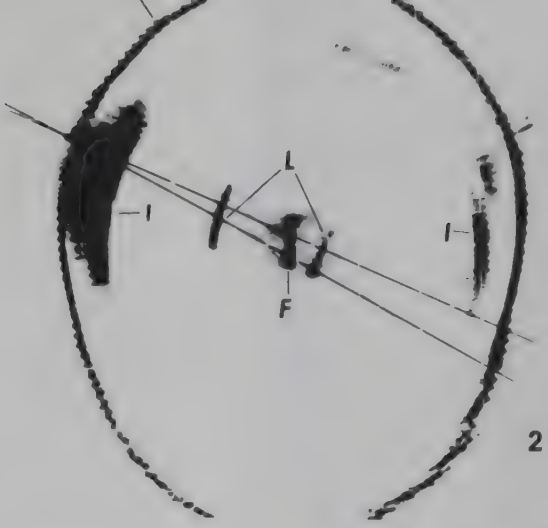
The scanner consists of a water-filled tub into which a patient lying on a stretcher immerses his head to the level of the eyes and ears. Water is used because it provides a more efficient medium for propagating ultrasonic waves than air. A ring mechanism inside the tub moves a scanning ultrasonic transducer around the head. The transducer, which is connected to a transmitter and receiver, sends short ultrasonic pulses of microsecond duration and receives the echoes reflected at the interfaces of two dissimilar substances or tissues, for example echoes from water-scalp and ventricle-brain tissue interfaces. These echoes, after being electronically amplified and suitably processed, appear on a large cathode ray tube screen. They trace a picture of a cross-section of the head, as they are being received from the various reflecting structures. This picture is then photographed by a camera and a permanent record of the brain section on a one to one scale is obtained. By raising or lowering the transducer with respect to the head, it is possible to obtain several horizontal sections at different levels and by tilting the ring to obtain coronal or oblique sections.

The intracranial structures from which echoes have been received are the fluid filled ventricles, the insula, the falx and the mid-

The new brain scanner in operation. Dr. Makow (right) is preparing to photograph the horizontal scan of the subject's brain, which appears on the cathode ray tube.



Horizontal scan on 57-year-old female patient showing a 2 millimeter shift of 3rd ventricle to the left. A shift of 2 millimeters is on the borderline between a normal and pathological condition.
V: 3rd ventricle; I:brain-skull interface;
S: scalp-water interface.



Horizontal scan on 49-year-old female showing asymmetry of the lateral ventricles caused by two tumors, one on the left and one on the right side of the midline, but in different locations.
F: falx; L: lateral ventricles.

brain. Brain disorders may displace these structures, destroying their symmetry, or cause their enlargement, for example by blocking the outflow of cerebral fluid. The displaced position of the corresponding echoes on the picture of a head section is then indicative of such disorders as shown in Figures 1, 2, 3, and 4.

The objectives of Dr. Makow's work are to produce a diagnostic tool which will show precisely and reliably the important intracranial structures, in a short time and at little discomfort to the patient.

"Considerable progress has been made in meeting these objectives," Dr. Makow says.

Recent examinations of hospitalized patients with the new scanner in Montreal have yielded encouraging results. A nearly complete agreement has been obtained with radiographic findings and neurological studies on the 26 persons examined, 11 of them with serious brain disorders. This is a major improvement over the agreement figure obtained with the previous model last year. In addition to greater reliability, the maximum error in echo location has been reduced from three to two millimeters, which is considered satisfactory for a measurement of this kind.

"This method", says Dr. McRae, "shows great promise for the screening of patients suspected of having brain tumors, hydrocephalus (dilated ventricles) and unilateral brain damage."

Horizontal scan on 9-year-old boy showing a slightly compressed right midbrain image which is shifted to the left by a tumor in the right half of the brain.
B: midbrain; T: temporal horns.

Coronal scan on 59-year-old male with grossly enlarged lateral ventricles. Normal lateral ventricle echoes appear at half this distance from the midline echoes.
V: 3rd ventricle; L: lateral ventricles.

Grants – Scholarships

The National Research Council of Canada announces a major reorganization of its machinery for handling applications by university professors for grants in aid of research and applications for scholarships by university graduates.

The reorganization has been made necessary as a result of a large increase over the last five years in the number of applications for grants and scholarships, due in large part to the growth of Canadian universities. In addition, many more fields of scientific investigation are represented in applications now being made to Council.

Under previous machinery, applications for grants and scholarships were reviewed by Grant and Scholarship Selection Committees, each with a member of the National Research Council acting as Chairman. The Council consists of the President, Vice-President (Administration) and two Vice-Presidents (Scientific) and not more than 17 members appointed by the Governor in Council.

number of committees, it has become impossible to assign a Council member to each committee; nor can conveners be provided for all committees from NRC staff.

Under the reorganization, the chairman of a committee need not necessarily be a Council member and may be selected from the staffs of Canadian universities to serve for specified terms. For 1966-67 all Chairmen are from universities.

The plan also makes it possible for conveners to be other than Directors of NRC divisions. Other scientists from NRC as well as other government laboratories now may serve as conveners or co-conveners of committees, especially in scientific disciplines not represented in Council laboratories.

Groups of Selection Committees will report to the Standing Committee on Grants and Scholarships through a designated Council member for confirmation of committee recommendations. The Council member also will inform the Standing

Manitoba, assisted by Dr. B. W. Currie, Dean of Faculties and of Graduate Studies, and Director of the Institute of Upper Atmospheric Physics, University of Saskatchewan, is the Council member for this group of committees).

Chemistry and Pharmacy (R. Rivest, University of Montreal); Chemical and Metallurgical Engineering (H. E. Petch, McMaster University).

(Dr. H. E. Gunning, Professor and Head of the Department of Chemistry, University of Alberta, assisted by Dr. D. J. LeRoy, Head of the Department of Chemistry, University of Toronto, is the Council member for this group of committees).

Mechanical Engineering (W. B. Rice, Queen's University); Electrical Engineering (J. M. Ham, University of Toronto); Civil Engineering (W. R. Drynan, University of Waterloo); Earth Sciences (R. E. Folinsbee, University of Alberta).

(Prof. L-P. Bonneau, Professor of Applied Thermodynamics, and

arships, which made the final decision on the application.

Ten Selection Committees and three Associate Committees considered applications for grants in aid of research and three Selection Committees assessed scholarship applications, a total of 16.

With the growth in the size and number of universities over the last five years, the work of these committees became onerous, particularly for members of Council acting as Chairman and for Directors of NRC's laboratory divisions in their capacity as conveners or secretaries of committees.

The large increase in applications has also made it necessary for the Council to increase the number of Grant and Scholarship Selection Committees to 22 from 16. They include 15 Grant Selection Committees, two Associate Committees—Dental and Experimental Psychology—and five Scholarship Selection Committees.

As a result of this increase in the

Cellular Biology and [illegible] (A. C. Blackwood, Macdonald College, McGill University, Montreal); Animal Biology (A. W. A. Brown, University of Western Ontario); Plant Biology (L. H. Shebeski, University of Manitoba); Dental (Jean-Paul Lussier, University of Montreal); Experimental Psychology (Dalbir Bindra, McGill University).

(Dr. W. S. Hoar, Professor and Head, Department of Zoology, University of British Columbia, assisted by Dr. G. Krotkov, Department of Biology, Queen's University, is the Council member for this group of committees).

Physics (W. Opechowski, University of British Columbia); Nuclear Physics (R. E. Bell, McGill University); Computer Facilities (D. B. Scott, University of Alberta); Computer & Information Science (J. M. Kennedy, University of B.C.); Mathematics (G. Duff, University of Toronto).

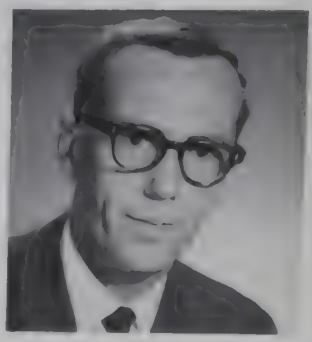
(Dr. H. E. Duckworth, Vice-President (Development), University of

Scholarships, Studentships, Special Scholarships and Postdoctorate Fellowships. The chairmen of these committees will be A. H. Black of McMaster University; R. U. Lemieux of the University of Alberta; G. Setterfield of Carleton University, Ottawa; and G. A. Harrower of Queen's University.

The fifth Scholarships Selection Committee, under the chairmanship of Abel Gauthier of the University of Montreal, will consider applications for 1967 Science Scholarships. These scholarships, designed to assist outstanding young Canadians to obtain doctorate degrees in science and engineering, mark the 50th anniversary of the Council's scholarship program and the Centennial of Canadian Confederation. A total of 50 of these scholarships will be available annually starting in 1967. Recipients will receive an annual amount of $5,000 for a three-year period, with scholarships being renewable for a fourth year if necessary.

APPOINTMENTS – AWARDS

Air Marshal Clare L. Annis was appointed General Manager of Canadian Patents and Development Limited, effective Sept. 1, 1966. He had been Chief of Technical Services for the three Armed Services since 1964.



Brian D. Leddy was appointed Secretary of NRC, effective Nov. 4, 1966. Mr. Leddy also is head of Administrative Planning Service, a position he has held since 1965.

Dr. G. L. Osberg, a chemical engineer, was appointed Chief Financial Officer of NRC, effective Nov. 14, 1966. Dr. Osberg had been head of the Chemcial Engineering Section of NRC's Division of Applied Chemistry since 1955.

F. R. Park, an electrical engineer, was appointed Associate Awards Officer of NRC's Awards and Committee Services Branch, effective Dec. 1, 1966. Mr. Park had been Deputy Head of the Upper Atmosphere Research Section of the Division of Radio and Electrical Engineering since 1956.

Dr. W. G. Schneider, Vice-President (Scientific) of NRC, received an Honorary Doctor of Science Degree from York University at Convocation exercises Oct. 14, 1966. He also delivered the Convocation address.

Helicopter De-Icing

The National Research Council operates the only facility of its kind in the western world for the study of the effects of icing on the flight performance and handling characteristics of helicopters and for the evaluation of methods of icing protection.

The facility, operated by the Low Temperature Laboratory of NRC's Division of Mechanical Engineering, is capable during the winter months, when the temperature is below freezing, of simulating the natural icing conditions which helicopters encounter during actual flight. It produces a huge artificial cloud of water droplets in which helicopters can hover some 50 feet above the ground.

The droplets in the icing cloud turn into ice when they impinge on (or strike) the helicopter. This makes it possible for helicopters to be subjected to controlled icing conditions in flight, at a safe height and without the inconvenience of having to fly considerable distances from base to encounter natural icing conditions.

Icing is a major flight hazard for helicopters. Their rotor blades, which provide both lift and forward flight, travel many times farther and faster through the air than the helicopter itself. Thus, in an icing condition, the blades accumulate ice faster than other parts of the helicopter, creating serious aerodynamic effects.

The centrifugal force imposed on the ice by the rotation of the blades causes some of the ice to be thrown off the blade when the ice mass becomes great enough to overcome adhesion. However, this "self-shedding" of ice creates two secondary hazards. Unequal amounts of ice may be shed from the blades, causing severe or even dangerous out-of-balance conditions. And ice thrown from the blades may be sufficiently massive to cause damage to other parts of the helicopter.

Helicopters powered by gas turbine engines face the additional hazard of engine icing unless adequate protective measures are taken. Electrically heated blankets may be attached to the engine's air inlets to prevent ice formation in this area. Hot gases

The NRC spray rig to study icing on helicopters in flight with the spray nozzle array lowered.

Close-up of an iced rotor blade hub (top). An iced rotor blade after a test in the spray rig (bottom).

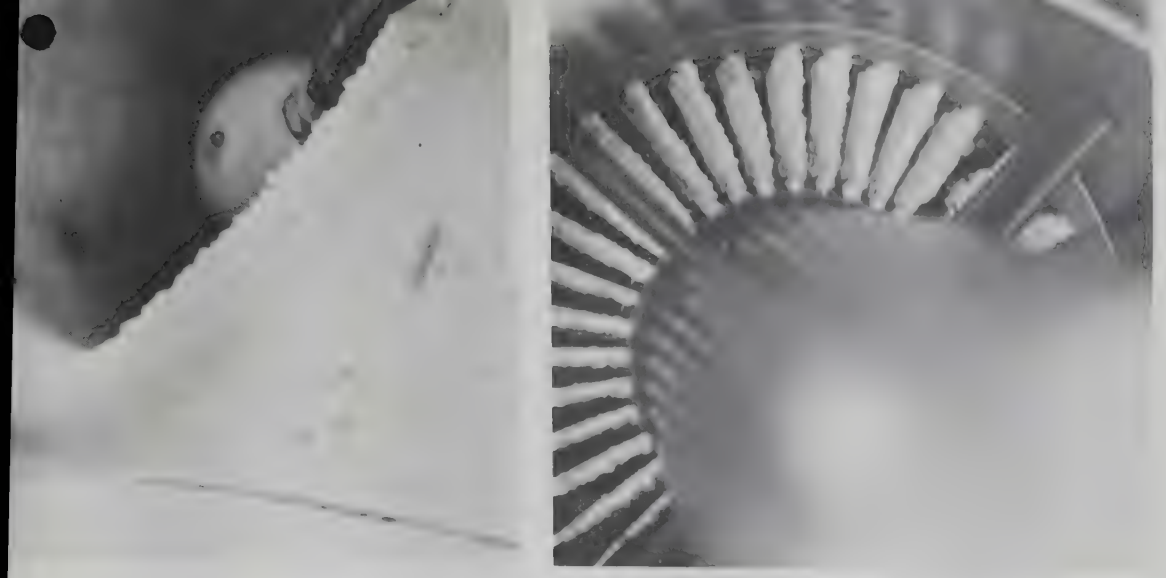
from the engine compressor may be distributed to the first stage stator blades to prevent ice formation on them.

Two methods are used to shed ice from the rotor blades of a helicopter—chemical anti-icing and electrical de-icing.

The electrical method involves the use of a heater mat on the leading edge of the rotor blade. When the mat is heated a thin layer of ice in contact with it is melted, destroying the adhesion of the rest of the ice, which is then thrown off by centrifugal and aerodynamic forces. If heat is applied periodically, the maximum thickness of ice can be controlled with a minimum expenditure of electrical energy.

A chemical such as alcohol may be used to prevent the formation of ice on the rotor blades. It can be distributed over the blade by discharging it through orifices or nozzles located along the blade leading edge in such a way that the fluid flows over both upper and lower surfaces. The alcohol mixes with the cloud water droplets, and prevents the mixture from freezing.

The facility, known as a spray rig, is located at NRC's National Aeronautical Establishment site near Ottawa's Uplands Airport. De-icing tests are conducted under



The type of icing that occurs in the inlet of a helicopter's gas turbine engine (left). Icing on the engine's stator blades (right).

the supervision of R. D. Price while icing research is directed by J. R. Stallabrass.

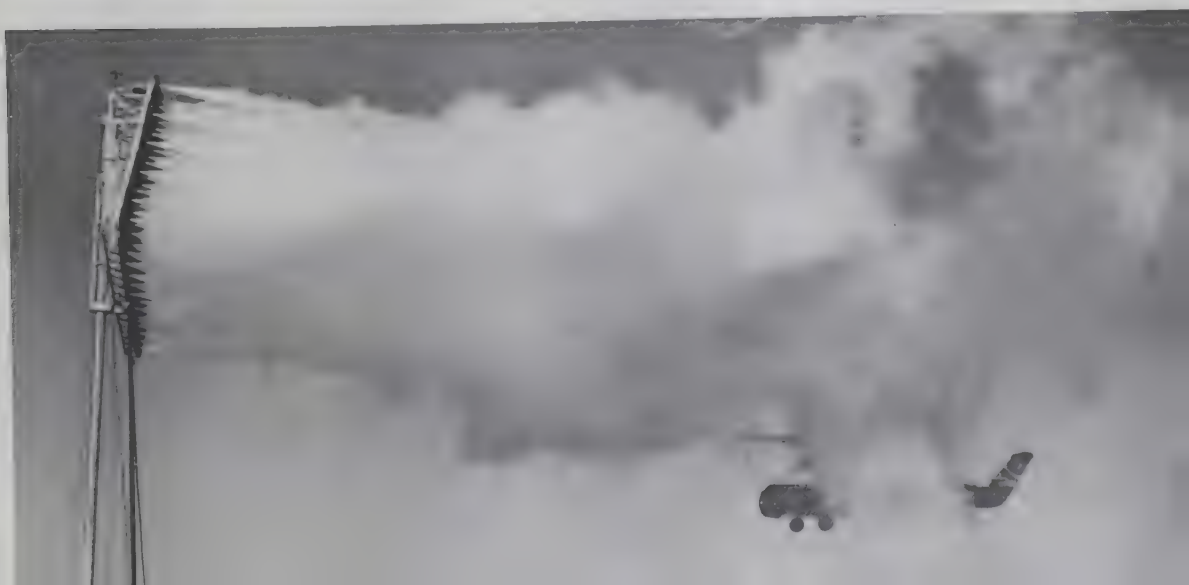
The rig consists of a welded steel framework on which is mounted a spray nozzle array measuring 75 feet by 15 feet. Steam and water are fed under pressure to 161 steam atomized water nozzles on the array to produce the icing cloud. The array can be raised to a height of 60 feet on a supporting mast and rotated to comply with the wind direction.

The rig was built in 1954 and enlarged to its present size in 1957. It has been operated successfully every winter as a research tool and to test de-icing systems on a wide range of helicopters.

During this period a total of 24 helicopters from manufacturers or users in Canada, the United States, the United Kingdom and France have been tested. Six or seven helicopters will be tested during the winter of 1966-67.

T. R. Ringer, head of the Low Temperature Laboratory, says helicopters without de-icing equipment accumulate ice very rapidly when they encounter icing conditions. In some conditions they may not be able to withstand more than a few minutes of ice build-up on their rotor blades. Formation of ice in the engine also reduces power seriously, at a time when additional power is required to offset ice build-up on the blades.

Side view of a helicopter hovering in the icing cloud produced by the spray rig.



Neutron Dosemeter

A compact, portable instrument has been built by the National Research Council to ensure the safety of scientists who will be working with high energy radiations in a new NRC laboratory complex.

The laboratory will provide facilities for the establishment of standardization procedures for the measurement of electrons, X-rays and neutrons of higher energies and intensities than can be measured at present at NRC. These measurements and standards will ensure the safer use of higher energy ionizing radiations by hospitals, research institutions and industry.

The equipment for the laboratory will include a 35,000,000 electron-volt linear electron accelerator for standardization and research in the measurement of high voltage X-rays and electrons and a 4,000,000 electron-volt positive ion accelerator for neutron standardization and measurement and for the study of neutron reactions.

The new instrument—a neutron dosemeter—will be used to measure the dosage or quantity of neutron radiation produced by the 4,000,000 electron-volt accelerator and also of radioactive neutron sources which will be used by the laboratory in its standardization work. It could also be produced commercially for use in other laboratories where high energy neutrons are present.

Information provided by the dosemeter will make it possible for the laboratory to establish work programs that will prevent scientists and technicians from receiving overdoses of radiation.

The monitor is a lightweight version of dosemeters now available commercially for measuring neutrons. These existing dosemeters are unwieldy and virtually non-portable because of the size and weight of a 30-pound polyethylene sphere which slows down neutrons to a point where they can be measured. The actual measuring of the neutrons is done by what is known as a BF_3 Counter in the centre of the sphere.

Dr. K. W. Geiger and Dr. E. Rotondi of the X-Rays and Nuclear Radiations Section of NRC's Division of Applied Physics reduced the weight of the sphere by a factor of three to nine pounds, and its diameter to 7⅞ inches from one foot, producing an instrument with a high degree of portability and accuracy. This was achieved by incorporating a cadmium shell four inches in diameter within the smaller polyethylene sphere to help slow down neutrons before they strike the counter.

(Dr. Rotondi was associated with Dr. Geiger in the development of the dosemeter as a Postdoctorate Fellow from the Settore Radiazioni del CNEN, at Frascati, Italy. He recently completed his fellowship and has returned to the nuclear research centre at Frascati).

Dr. Geiger says readings on a calibrated dial on the dosemeter will give the amount of biologically effective dose to which an individual is exposed in a laboratory where neutron radiation is present.

The Department of National Health and Welfare has established maximum permissible dose limits to which the human body may be exposed. The new instrument will make it possible to determine the length of time an individual may remain in a neutron laboratory or whether the laboratory can be entered at all.

The dosemeter can also be used as a remote control instrument which is located within an area where neutrons are being produced. The information it collects on the dosage or quantity of neutron radiation is transmitted by cable to a calibrated dial outside the laboratory.

Dr. Geiger (left) and Dr. Rotondi assemble the nine-pound polyethylene sphere of their neutron dosemeter. Dr. Rotondi is putting the top half of the cadmium shell in place.

Humane Animal Trap

A new lightweight trap developed by the National Research Council will make the trapping of animals for their pelts more humane and more economical.

The trap kills an animal instantly by breaking its neck or spine, eliminating the suffering involved in present methods of trapping.

Traps now in use seize an animal's foot in their vise-like jaws. The animal suffers until the trapper arrives and kills it or until it starves to death or freezes in winter. In some cases the animal will gnaw the trapped foot off when it becomes numb and escape, maimed for life.

This vise-type of trap can also be placed around the exit hole of an animal's lair. When the animal emerges from its lair, the trap seizes it by the neck.

The use of this type of trap can cause damage to an animal's pelt, seriously reducing its commercial value. The new trap, developed by M. S. Kuhring and L. E. Percival of the Engine Laboratory of NRC's Division of Mechanical Engineering, also will eliminate this kind of damage.

"We feel the new trap offers a method of trapping which is humane and more effective than present methods, while costing the trapper little or nothing extra in his outlay for equipment," Mr. Kuhring says.

The trap was developed at the request of the Wildlife Service of the Department of Northern Affairs and National Resources and the Canadian Federation of Humane Societies. It was designed in consultation with the Canadian Trappers Association.

The trap consists of two metal rings or frames, one slightly smaller than the other, which are placed on the ground in a vertical position. The smaller ring pivots on the larger one and is placed in tension by springs. An animal attracted by bait, has to place its head through the rings. In doing so it trips a trigger, releasing the smaller ring which travels through 180 degrees of arc striking the animal on the neck or just below the shoulders with enough force to break the spine or neck but not damage the pelt. The new traps can also be placed in a horizontal position over the exit hole of an animal's lair.

Another advantage of the new trap is that it has interchangeable parts. A damaged trap can be repaired from a supply of parts which a trapper can carry in his knapsack. Traps now in use usually do not have replaceable parts and must be scrapped if they are damaged.

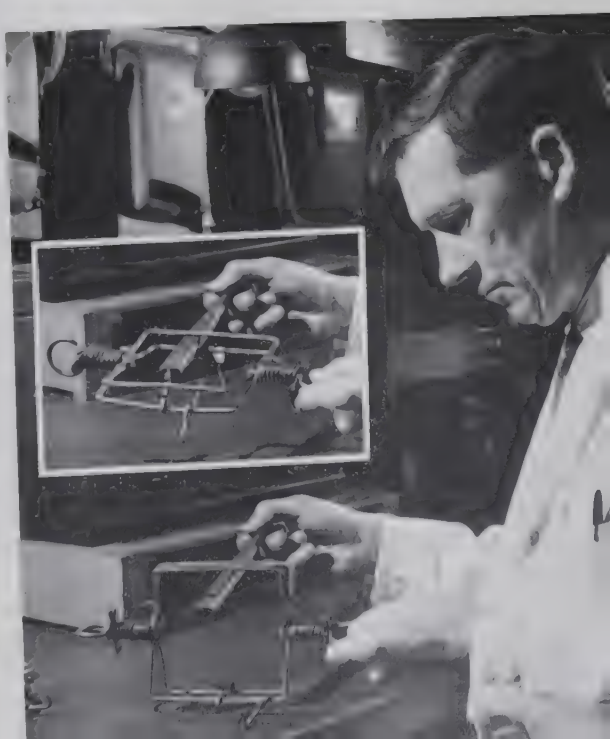
The amount of tension in the springs of the trap can be varied for trapping different species of animals. Different tensions must be used because a mink, for instance, has very strong neck muscles and the amount of force that will kill a muskrat will only injure a mink.

Trappers must rust their traps slightly because animals will avoid shiny objects. Mr. Kuhring's group now is experimenting with different ways of darkening the metal during production of the trap. Several methods attempted so far have proved unsuitable because they may give the metal an odor which drives animals away from the trap.

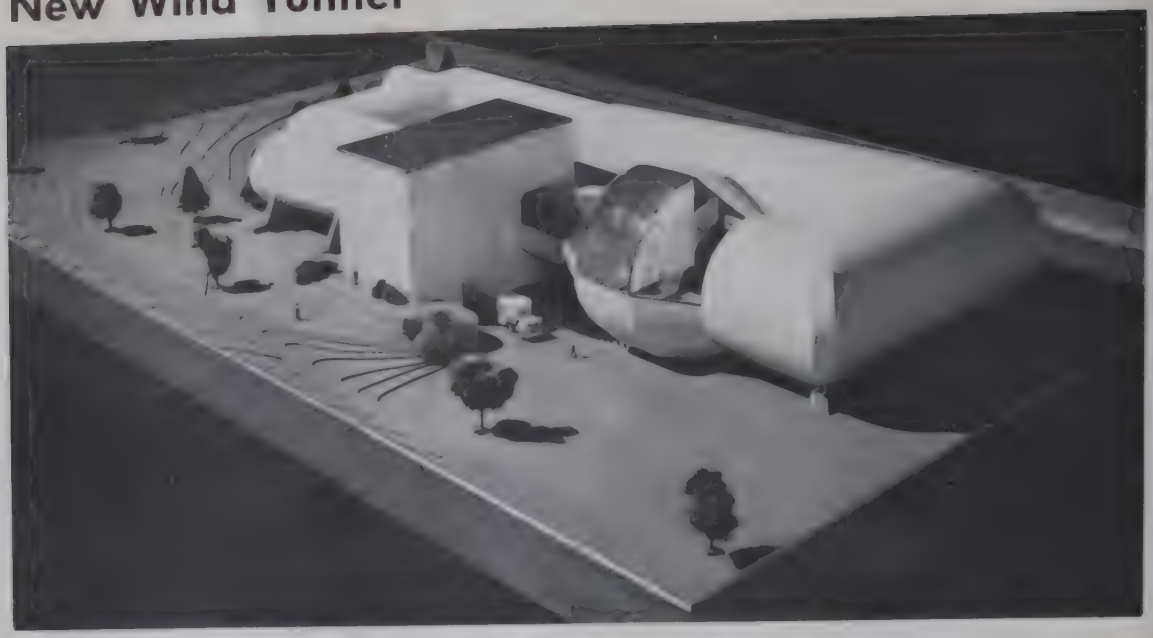
A pilot group of 70 traps has been distributed among members of various trappers associations and provincial agencies for testing. A contract also has been negotiated with the Caughnawaga Indians near Montreal to produce 2,500 traps for further field tests.

Development of the new NRC trap will not only establish a new industry in Canada but will result in Canadian trappers being able to buy a more humane and economical trap.

Mr. Percival uses a hammer handle to trigger a trap for muskrat and mink. Triggered trap springs on hammer handle (inset).



New Wind Tunnel



Model of the new wind tunnel to be built in Ottawa by NRC's National Aeronautical Establishment for use by the Canadian aircraft industry.

Four contracts valued at $4,529,491 have been awarded by the Department of Public Works for the construction of a huge wind tunnel at the National Research Council's National Aeronautical Establishment.

The tunnel, to be located at NAE's main site near the Ottawa International Airport, will be used by the Canadian aircraft industry for industrial research and development of vertical and short take-off and landing aircraft.

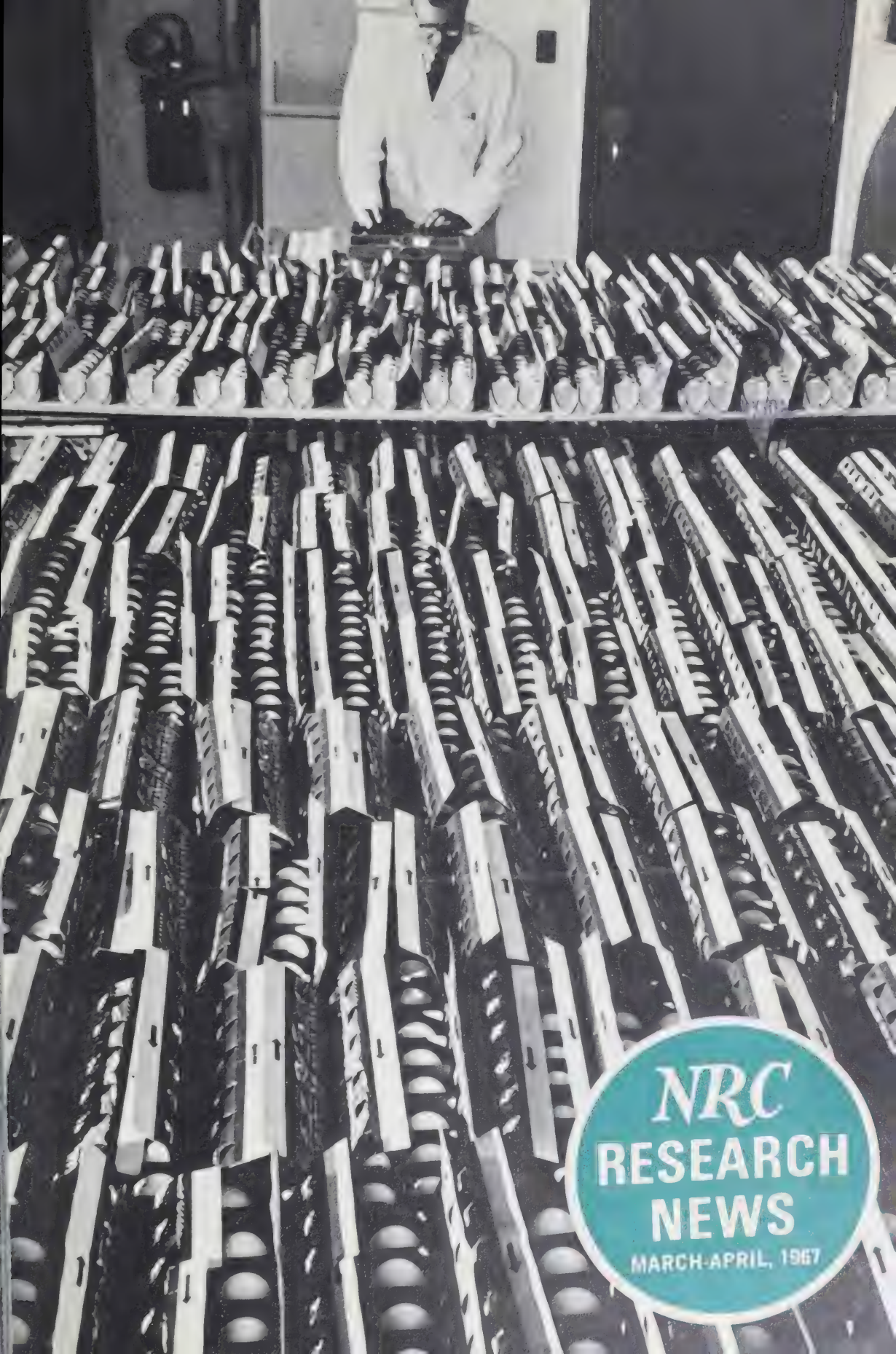
The structure, the largest wind tunnel in Canada, will have a 30-foot square working section for the testing of model aircraft of up to 20 feet in wing span.

It will take the form of a rectangle air circuit with a length of 400 feet and a maximum width of 170 feet. Most of the tunnel will be an exposed steel structure, with only the 30-foot working section housed within a laboratory building. A settling chamber 82 feet in diameter will ensure that air will flow smoothly into the working area and simulate actual flight conditions.

A large working area is essential for research on V-STOL aircraft. A main characteristic of this type of aircraft is that huge quantities of air must be forced downward by the aircraft's power plant and wing to permit vertical or short take off. This can only be simulated in a large working area.

Horton Steel Works Limited of Toronto has been awarded a $2,369,600 contract for the construction of the main shell of the tunnel; Canadian Vickers Industries Limited of Montreal a $1,453,341 contract for the fan and test sections; Siemens Canada Limited of Montreal a $601,800 contract for a 10,000 horsepower fan drive which will pump air through the tunnel, and P. E. Brule Limited of Ottawa a $104,750 contract for concrete foundations and associated works.

The tunnel is expected to be completed in 1968. Consulting engineers for the structure are Dilworth, Secord, Meagher and Associates Limited of Toronto.



NRC RESEARCH NEWS

MARCH-APRIL, 1967

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University Support

The National Research Council's proposed program of support for university research in the 1967-68 fiscal year shows an increase of $11,350,000 as compared with the previous year.

The spending program for university grants and for scholarships for graduate students totals $45,500,000, up 33% from $34,150,000 in the 1966-67 fiscal year.

The funds earmarked for university support in 1967-68 compare with $40,693,000 for the administration, operation and maintenance of the Council's own laboratories.

The vote for university support is separate and distinct from the vote for operation of NRC Laboratories and from the vote to promote research in industry.

Funds voted by Parliament for university support cannot be used for any other purpose. However, revenues earned by Council laboratories through the use of their facilities by private individuals can be used to bolster the university research program.

Funds for the Medical Research Council are provided by Parliament under a separate vote.

Cover: E.A. Rooke of NRC's Food Technology Section prepares eggs for cooling study. *See page 5.*

Back Cover: Huge wind tunnel for NRC's National Aeronautical Establishment begins to take shape near Ottawa's International Airport. Helicopter is framed by one of the sections of the tunnel's air circuit.

Clear Air Turbulence

The T-33 jet aircraft used in studies of clear air turbulence.

A better understanding of the effect of high altitude air turbulence on aircraft behavior and the problems of control arising during flight in such turbulence is being sought by the National Aeronautical Establishment of the National Research Council.

Air turbulence at low altitudes is relatively commonplace. When pilots know from weather reports and other information, such as their weather radar, that they are about to enter an unstable area where turbulence is likely to exist, they can reduce speed or avoid entering the area, instruct passengers to fasten safety belts and take other protective action.

High altitude clear air turbulence cannot be detected or foreseen in advance. Aircraft flying at high speeds can encounter clear air turbulence without warning. Passengers may be injured and control of the aircraft may become difficult.

Incidents due to clear air turbulence are rare events, but from a safety point of view there is a need to anticipate them. In May, 1963, for example, a Canadian passenger aircraft encountered severe air turbulence adjacent to the Rocky Mountains. Twelve passengers were severely injured and 18 other passengers and a stewardess received minor injuries.

Two energy sources for clear air turbulence are jet streams and mountain waves. A jet stream is a narrow high-level current of wind blowing with great force, while mountain waves are strong disturbances created by topographical features in mountainous areas.

NAE's Flight Research Section is using a specially modified T-33 jet aircraft to study clear air turbulence to enable aeronautical engineers to obtain information which will help mitigate this flight problem. This work also includes tests of infrared equipment designed to detect turbulence ahead of an aircraft.

Onboard instrumentation makes possible the determination of true gust velocities in three components. The longitudinal gust velocity is measured by a differential pressure transducer. The lateral and vertical components are sensed by vanes mounted on a boom in front of the aircraft. The measured vane angles are corrected for aircraft motion detected by accelerometers and rate gyros located near the centre of gravity. Continuous airspeed and altitude data are also recorded and total air temperature is obtained from a temperature probe. Data are recorded on a 14-channel magnetic tape recorder housed in the plane's nose.

"One of the reasons for extensive study of high-altitude turbulence — particularly mountain waves," according to Graeme Mather, who is in charge of this project at the Flight Research Section and one of the pilots of the T-33, "is that, surprisingly enough, very few measurements of this type of high altitude turbulence exist."

Findings may well affect the operation of present aircraft and the design of those still on the drawing board. An ability to avoid areas of clear air turbulence is becoming increasingly necessary as the aviation industry moves into the age of supersonics.

The highly-instrumented T-33 aircraft is used in low altitude studies (150 to 1,000) feet to extend existing flight data on low-level turbulence. The Section has recently turned its attention to high altitude turbulence. Exploratory flights have been con-

ducted from Edmonton, Salt Lake City, Utah, and Moffett Field in California.

These flights made initial tests of an infrared scanning radiometer built by Barnes Engineering of Stamford, Conn. This device, housed in an instrument pod underneath the T-33, attempts to detect clear air turbulence by determining the air temperature at fixed distances ahead of the aircraft. The infrared technique depends upon the assumption that clear air turbulence is directly associated with temperature changes in the atmosphere.

Initial flights to investigate mountain wave turbulence were made out of Edmonton in November, 1966. Edmonton was chosen as a base because of its proximity to the mountains and because of the common occurrence of the jet stream over Edmonton at that time of year.

During the Edmonton trials, an unusual weather pattern pulled the jet stream south over Utah. The T-33, chasing the jet stream, shifted its base to Salt Lake City for four days.

In these trials it was found that one of the most successful ways of delineating areas of clear air turbulence was to rely on rough-air reports from commercial airliners.

Tests shifted to Moffett Field in February for a month-long mountain wave study in the region of the Sierra Wave. During these tests T-33 flights were co-ordinated with those of a high altitude Canberra aircraft from the Royal Aircraft Establishment in England.

Preliminary results from the Sierra Wave project at Moffett indicate that mountain waves and associated turbulence can extend into the stratosphere to altitudes of at least 45,000 to 50,000 feet. Such disturbances could well cause difficulties for future supersonic transports flying at these altitudes.

A.D. Wood, head of the Flight Research Section, says the T-33 has been grounded for further instrumentation as a prelude to tests this fall.

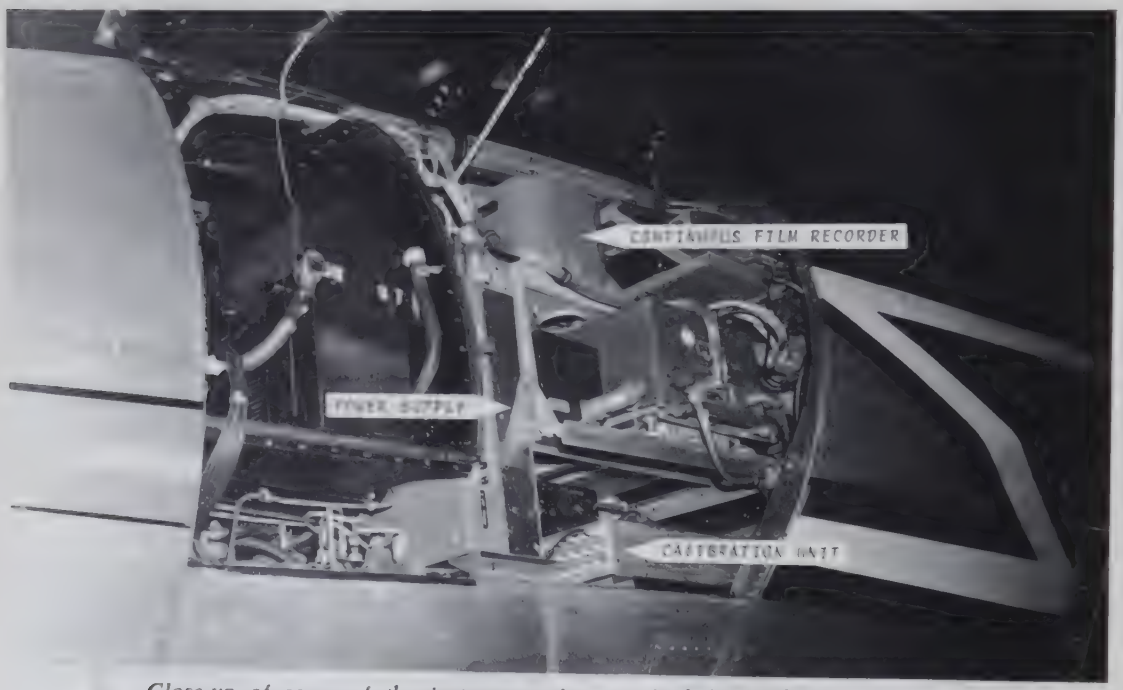
"We hope to have a Doppler Radar added to give us a more accurate method of determining wind velocity and also a radio altimeter."

He added that further tests may be carried out with the infrared scanner.

Initial tests of this instrument were only partially successful since the radiometer was found to be particularly sensitive to aircraft pitch changes. An aircraft pitch down by one degree, for example, with the radiometer scanning at 60 miles, meant the scanner would detect air 5,000 feet below the aircraft altitude. This air would be warmer by 10 centigrade degrees, due to the natural change of temperature with height.

This signal from aircraft pitch change would be sufficiently large to obscure any signal received from a temperature discontinuity of three degrees centigrade at a range of 30 miles which might be associated with turbulence.

Stabilization of the instrument is the most likely way of correcting this problem.



Close-up of some of the instrumentation required for turbulence research.

Egg-Cooling Study

E.A. Rooke of the Food Technology Section measures temperatures of eggs after cooling.

An egg cooling study indicates that cooling procedures used on farms and in egg grading stations contribute to the "watery white" problem. The tests, made by the Food Technology Section of the National Research Council's Division of Biosciences, in cooperation with the Department of Agriculture's Production and Marketing Branch, required 900 dozen eggs to simulate commercial practice.

Watery whites — egg whites which spread out thinly across the frying pan instead of standing in a thick mass around the yolk — have been known for over 40 years, but the incidence of the problem has increased markedly during the last 5-7 years. This increase coincides with increased use of egg washing machines in egg grading stations.

Since washing results in warming of the eggs, and since temperature is known to affect stability of the white, the increased incidence of watery whites may be related to washing and associated handling procedure.

In-plant measurements showed that eggs came to about 70°F during washing. After washing, the eggs are graded and packed in corrugated cardboard cases, 15 one-dozen cartons to a case. The eggs are then transferred to the cooler in pallet loads containing 60 or more tightly stacked cases.

"We found that when we duplicated this procedure under controlled conditions in the laboratory, it took 10-12 days for the eggs to approach the temperature of the cooler" said C.P. Lentz of the Food Technology Section.

"In contrast, when the wire baskets used only to a limited extend by the trade, replaced the corrugated cardboard cases, cooling was accomplished in 1½-2 days".

The results indicate the importance of air circulation through the cartons and adjacent to the eggs themselves for adequate cooling.

Further tests will be made to determine in more detail the rate of cooling necessary to minimize the watery white problem.

Research on Ice

Dr. Whalley demonstrates the use of equipment which measures the dielectric properties of ice under pressure.

Canada is playing a leading role in world research on the properties of ice.

The High Pressure Section of the National Research Council's Division of Applied Chemistry has discovered the existence of two new forms of ice that exist under very high pressure and low temperature. These forms, or phases, are defined as distinct physical states of matter.

The gaseous, liquid and solid states of matter are easily recognized, but there are also various solid phases characterised by different molecular arrangements. Graphite and diamond are two phases of carbon that exist normally at atmospheric temperature and pressure.

Dr. Edward Whalley, head of the High Pressure Section, says scientists are interested in the chemistry of ice not only because it will represent an important addition to man's knowledge, but also because of the importance of the water molecule in the basic life processes. Ice is an excellent model to use to learn more about the liquid phase.

Only one phase of ice (ice I) exists under natural conditions. Such extremes of temperature and pressure are required for the other phases to come into existence that a glacier would have to be over ten miles thick to create sufficient pressure at the base to create a high-pressure phase.

The existence of phases II to VI has been known to scientists for over 50 years, and phase VII for 30 years. Phases VIII and IX were discovered by the NRC team in their general study of the properties of all the phases of ice, which began in 1960. Ice is now known to have more phases than any other substance. These discoveries have won the recognition of scientists all over the world, including the Soviet Union.

All the phases of ice are crystalline, and the oxygen atoms are in regular arrangements. In some of the phases, the hydrogen atoms are also in regular order. They form hydrogen bonds in an orientationally ordered pattern.

In other phases the hydrogen atoms are disordered. The molecules have enough energy to flip over and rearrange themselves. A very large number of configurations is possible in these cases. These actions give the phases of the solid substances their peculiar characteristics. At very low temperatures the molecules do not have enough thermal energy for this action to take place.

In metallurgy, the various heat treatments favor the existence of the phases that give a metal its mechanical properties, such as hardness and malleability.

It is easy to distinguish the properties of the water molecules in its liquid or gaseous form. Density and volume change very ob-

viously. Some of the phases of the solid form, ice, however, and especially those which come into existence at very low temperatures or very high pressures, present more subtle differences and require very sophisticated measurement.

The electrical properties (conductance and capacitance) of the ice crystals are measured for each phase to find the quantitative differences in the action of the atoms and molecules.

Ice I, or natural ice, is orientationally disordered.

Ice VII comes into existence at pressures of over 300,000 pounds per square inch (psi). Atmospheric pressure at sea level is only 14.7 psi.

The group measured the change in capacitance and conductance of ice VII by subjecting it to an AC electric field. They found that below 0°C the conductivity and dielectric constant became very low. This suggested the existence of a previously unknown phase with the hydrogen atoms ordered. The phase was further examined and confirmed and called ice VIII.

A technique was developed by the NRC group to measure the low frequency infra-red vibrational spectra of the crystals in each phase; that is, to measure what wavelengths of infra-red light are absorbed by the vibrations of the molecules of each phase.

Using this technique, it was discovered that ice III, which is disordered at relatively high temperatures, (about -30°C), became orientationally ordered when cooled to low temperatures. At these temperatures, ice III's electrical properties change. At about -100°C it becomes ordered and forms a phase which is called ice IX.

This instrument is used by Dr. Whalley to measure the phase boundaries of ice under pressure.

Materials Research

The National Research Council has awarded special grants, with a total value of $1,200,000 over the next three years, to three Canadian universities for interdisciplinary research on materials used in industry.

The grants, known as Negotiated Development Grants, go to the University of Toronto, McMaster University, Hamilton, Ont., and the University of British Columbia. They are designed to assist the three universities to develop and build up more quickly their competence in materials science and speed the establishment of Materials Science Research Centres at the three institutions.

The over-all objective of this new grants program is to help all Canadian universities to develop research centres of excellence in specific areas of science and technology regarded as of vital importance to Canada.

The University of Toronto will receive $325,000, with $125,000 being provided in 1967-68, $125,000 in 1968-69 and $75,000 in 1969-70.

McMaster University will receive $500,000, with $200,000 being provided in the first year, $200,000 in the second year and $100,000 in the third year.

UBC will receive $375,000, with $150,000 being provided in the first year, $150,000 in the second and $75,000 in the third.

Active programs in materials research now are underway at the three universities. They were centred initially in each university's Department of Metallurgy, but are increasingly encompassing other departments.

At each university new buildings to house Materials Science Research Centres are nearing completion.

NRC's regular support of universtiy research is given as a grant-in-aid to university professors after an assessment of an applicant's demonstrated or potential ability to do research. The new Negotiated Developments Grants are intended to support interdisciplinary research programs co ducted by groups of capable and highly m tivated investigators in new areas of i vestigation or in circumstances warranti an intensification of research effort.

Materials science research involves t study by groups of scientists—metallurgis chemists, physicists and others—of a bro range of materials of importance to Canad future economic development.

The grants to the three universities a for three years but continuing support w be available in the form of regular researc grants to individual scientists in line wi existing Council policy. In addition unive sity staff members participating in a mate ials research centre program may app during the three years for both regular r search grants and also grants to purcha equipment.

The Negotiated Development Grants pr gram will permit each university maximu flexibility in the use of the funds it receive Funds may be used for the purchase of e pensive equipment, recruitment of staff a support of graduate students. Salaries staff, paid in whole or in part out of t grants, will become the responsibility of t university at the end of the three-year perio

ıedical Research

The Medical Research Council and the iversity of Montreal have announced that University has been awarded the first ınt under a major new program of the uncil to stimulate high-level medical re-ırch in Canada.

The new program will support the estab-ıment and the maintenance of a limited mber of Medical Research Council Groups hin the framework of medical schools in nadian universities. It is designed to pro-le financial support of groups of two or ore outstanding medical investigators over period of years in what appear to be espe-lly productive areas of medical research.

The Council and the University of Mon-al have signed an agreement under which e Council will support for a five-year riod a multidisciplinary group which will vestigate problems concerning the organ-ation of the nervous system. The group ill include two neurophysiologists, a neu-anatomist, a neurochemist and a bio-edical engineer.

The nervous system can be considered as communications network made up of cells ith long fibres. Cells can be connected to ne another by these long fibres or the ores of one cell can be connected directly another cell.

The Group's research will include studies what transpires at the point (synapse) at hich a nervous impulse passes from one euron (cell) to another. During recent ars a number of naturally occuring chemi-l substances have been suggested as ossible candidates for synaptic transmitters the brain, and others as possible modu-tors of neuronal excitability.

The total amount of the grant over the ve-year period will be approximately 1,250,000.

Dr. H.H. Jasper, 61, a Canadian neuro-ysiologist with an international reputation, ill be director of the Group. At present Dr. ısper is Professor of Neurophysiology at e University of Montreal. His most out-standing work has been concerned with the electrical stimulation of individual nerve cells and their response.

The four other principal investigators of the Group are:

Dr. J.P. Cordeau, 45, Chairman of the Department of Physiology at the University of Montreal. A neurophysiologist, Dr. Cordeau also is an engineer. He is Chairman of the Grants Committee on Neurological Sciences and Morphology of the Medical Research Council.

Dr. Marc Colonnier, 37, Assistant Professor in the Department of Physiology at the University of Montreal. He is a neuro-anatomist.

Dr. Nico M. van Gelder, 33, a neuro-chemist, now Assistant Professor in the Department of Pharmacology at Tufts University in Boston. He is joining the Laboratory of Neurological Sciences at the University of Montreal.

Dr. Fernand A. Roberge, 32, Assistant Professor in the Department of Physiology at the University of Montreal. He is a bio-medical engineer.

New Library Function

The main reading room of the National Science Library of Canaaa.

The National Research Council is taking action to ensure that the world's literature resources in the medical and health sciences are readily available to Canadians working in these fields.

The Council has assigned this responsibility to the National Science Library of Canada, a division of NRC which will serve as the national centre for scientific and technical publications in the medical and health sciences. This new assignment enlarges the Library's present function of meeting the information needs of the scientific, engineering and industrial communities of Canada.

The new Library function, recommended to the government by Dr. J.J. Lussier, President of the Association of Canadian Medical Colleges, endorses proposals of a study committee headed by Dr. J.B. Firstbrook, Associate D e a n, Faculty of Medicine, Queen's University. This committee was made up of the deans of medical schools, medical librarians and representatives from the Medical Research Council and other appropriate government agencies.

The Library will expand its existing services by providing reference and bibliographical services in the medical and health sciences, co-ordinate and support the acquisition of publications in these areas and provide leadership in medical library practice, research and education.

These steps are designed to overcome a critical lack of medical and health literature in Canadian libraries and ensure the acquisition of new literature published in Canada and elsewhere in the world. They will enable the library to meet the literature demands of Canada's growing program of education, practice and research in medicine and related health fields.

Full implementation of the Library's new function cannot take place until the Library is housed in enlarged quarters. A new building which will relieve the present critical shortage of shelf and working space, is being planned for construction starting in 1968.

In the meantime, strengthening of the Library's medical literature resources will be carried out as rapidly as possible. An up-

dated listing of the bio-medical journals held by the Library will be prepared and distributed to libraries in Canada this year, and special efforts will be made to obtain medical journals which other libraries will not purchase because of infrequency of use. The Library recently purchased 200 foreign language medical journals, most of which are not held by Canadian libraries.

The Library now has a collection of more than 600,000 volumes. These resources have been developed in close co-operation with other federal libraries in Ottawa to the point where there now exists in Ottawa one of the world's outstanding collections of scientific and technical literature. Telex linkage with the major libraries and information centres of the world facilitates locating and obtaining publications and information not held in Ottawa or Canada.

Included in the Library's collection of over 15,000 journal titles are 1,600 bio-medical journals. These titles comprise the majority of the 2,300 journals which are indexed by the National Library of Medicine in Washington in their abstracting service "Index Medicus".

New Council Members

Richard D. Hiscocks

Dr. John M. Robson

Dr. Max Wyman

The appointment of three new members of the National Research Council and the re-appointment of four members whose terms had expired were announced April 1.

The three new Council members are Richard D. Hiscocks, Director of Future Projects and Research, The de Havilland Aircraft of Canada Limited, Downsview, Ont.; Dr. John M. Robson, Chairman, Department of Physics, University of Ottawa, and Dr. Max Wyman, Vice-President, University of Alberta, Edmonton.

Mr. Hiscocks joined NRC as a structural engineer in 1939 after graduating from the University of Toronto. He was head of NRC's Structures Laboratory in 1944-45 and joined de Havilland Canada as chief technical engineer in 1945. Before being appointed to his present position, he was chief aerodynamicist and chief engineer.

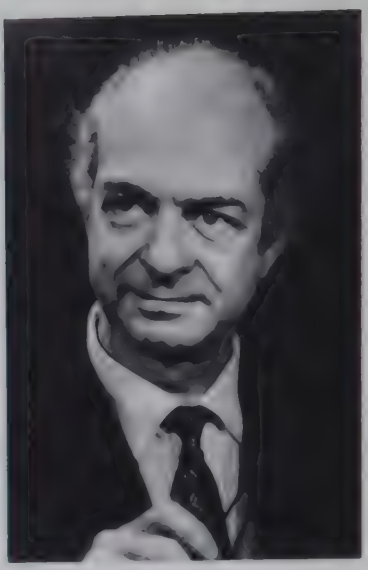
Dr. Wyman is a graduate of the University of Alberta and the California Institute of Technology. He was with NRC from 1940 to 1943 when he joined the University of Alberta. In 1963 he was appointed Dean of Science and in 1964 became Vice-President.

Dr. Robson, a graduate of Cambridge University, was involved in research during the second world war at Radar Research and Development Establishment at Malvern, Eng. From 1945 until 1960, when he was appointed chairman of the University of Ottawa's Physics Department, Dr. Robson was with Atomic Energy of Canada Limited.

The four re-appointed members are Dr. William H. Gauvin, Research Manager, Noranda Research Centre, Pointe Claire, Que.; Claude Jodoin, President Canadian Labour Congress, Ottawa; Dr. D.J. LeRoy, Head of the Department of Chemistry, University of Toronto, and Dr. H. Rocke Robertson, Principal of McGill University, Montreal.

The appointments and re-appointments are for three years.

Noranda Lectures



Prof. Linus Pauling

Prof. Hideki Yukawa

A series of lectures by world famous scientists and scholars, including five Nobel prize winners, will constitute one part of the tapestry of events marking Canada's Centennial Year and Expo 67.

The lectures, sponsored by Noranda Mines Limited, will be delivered in the Du-Pont of Canada Auditorium during the period of Expo 67. They will be one hour in length and are scheduled to start at 5 p.m. on the dates they will be delivered.

All lectures will be delivered before specially invited audiences. Applications for invitations should be sent to D. Hunka, Organizing Secretary, Science Programme, Expo 67, MacKay Pier, Montreal, Que.

Dates and names of speakers and the titles of their lectures:

May 8 — Prof. J. Tuzo Wilson, Canada, Geophysicist, Director, Institute of Earth Sciences, University of Toronto. "Terre des Hommes"

May 15 — Prof. H.B.G. Casimir, Netherlands, Theoretical Physicist, Director of Research, The Philips Co., Eindhoven. "Low Temperatures and their Applications."

May 22 — Prof. André Leroi-Gourhan, France, Social Scientist, Director - Ecole de fouilles de l'Université de Paris, Centre de Recherches Préhistoriques et Protohistoriques, Université de Paris. "Terre des Hommes Préhistoriques".

May 29 — Prof. Gunnar Myrdal, Sweden, Economist, Professor in Economics - Institute for International Economic Studies, Stockholm. "An Economist's Vision of a Sane World".

June 5 — Lady Robert Jackson (Barbara Ward), United Kingdom, Author, Economist, Lecturer, Assistant Editor of "The Economist". "A New History".

June 12 — Sir Macfarlane Burnet, Australia, Nobel Laureate (Medicine), Director - School of Microbiology, University of Melbourne. "Immunological Tolerance: Its Bearing on Transplantation & Autoimmune Disease."

June 19 — Dr. William Barry Wood, Jr., U.S.A., Microbiologist, Director, Department of Microbiology, The Johns Hopkins University, School of Medicine. "Cellular Defence Against Bacterial Infections."

June 23 — Prof. Bruno Zévi, Italy, Architect-Urbanist, Professor of Architecture, University of Rome. "Architecture 1967: Progress or Regression ?"

June 26 — Mr. K. Helveg Petersen, Denmark, Authority on Adult Education, Chairman, Planning Council for Higher Education. "New Trends in Education."

July 3 — Mr. Khushwant Singh, India, Author, Philosopher. "Orient Pearl in the World Oyster."

July 7 — Academician Nikolai Basov, U.S.S.R., Nobel Laureate (Radio Physics), Vice-Director, P.N. Lebedev Physical Institute, Moscow. "Quantum Electronics" (tentative).

July 10 — Prof. (Mme) Valerie Troitskaya, U.S.S.R., Geophysicist / Mathematician, Academy of Sciences, Moscow. "We and the Sun."

Sir Macfarlane Burnet

Academician Nikolai Basov

Academician Mikhail Sholokhov

July 17 — Dr. Augustus B. Kinzel, U.S.A., President, The Salk Institute for Biological Studies, San Diego. Founding President, National Academy of Engineering. "Industrial Research - Why, How and What ?"

July 24 — Academician Mikhail Sholokhov, U.S.S.R., Nobel Laureate (Literature), Union of Soviet Writers, Moscow. "Development Trends in Contemporary Literature."

July 31 — Prof. Stanislas de Sèze, France, Medical Scientist (Rheumatologist), Authority on the History of Medicine, Centre de Rhumatologie Viggo Petersen, Paris. "Progrès en Rhumatologie: un Siècle de recherches: 1867-1967."

August 14 — Prof. Hideki Yukawa, Japan, Nobel Laureate (Physics), Director, Research Institute for Fundamental Physics, Kyoto. "Creative Thinking in Science."

August 21 — Prof. Carl J. Friedrich, U.S.A. & Germany, Political Scientist, Historian, Philosopher, Universities of Harvard & Heidelberg. "Man and His Government."

August 28 — Prof. William A. Robson, United Kingdom, Jurist, Political Scientist & Authority on Management of Public Enterprises. Prof. of Public Administration, London School of Economics (Retired). "The Role & Conduct of Public Enterprise."

September 4 — Prof. Seyyed Hossein Nasr, Iran, Authority on Islamic Philosophy & Theology, University of Tehran. "Who Is Man ? - The Perennial Response of Islam."

September 11 — Prof. Ephraim Katchalski, Israel, Biologist, Head of the Biophysics Division, Weizmann Institute of Science. "The Role of Proteins and Nucleic Acids in Determining Life Processes."

September 18 — Prof. H. Bondi, United Kingdom, Astronomer. Professor, Dept. of Mathematics, University of London. "Cosmology, Enduring and Changing Features."

September 25 — Prof. Eric Martin, Switzerland, Medical Scientist. Policlinique Universitaire de Médecine, Geneva. "Le progrès et la santé de l'homme."

October 2 — Prof. Louis Armand, France, Engineer & Administrator. Member of the Board, French Atomic Energy Comm. Head of firm set up to complete channel-crossing tunnel. "La Diffusion de la Connaissance Technique, Impétus de Progrès."

October 9 — Prof. Linus Pauling, U.S.A., Twice-Honoured Nobel Laureate (Chemistry & Peace). Center for the Study of Democratic Institutions, Santa Barbara, California. "Science and the World of the Future."

October 16 — Prof. Karl Lôwith, Germany, Historian & Philosopher. Professor of Philosophy, University of Heidelberg. "Progress: A Fatality."

October 23 — Academician F Sorm, Czechoslovakia, Organic Chemist. President, Czechoslovak Academy of Sciences, and Director, Institute of Organic Chemistry and Biochemistry, Prague. "How to Fool the Cell (Antimetabolites & Analogues)."

Respiratory Air Cooler

Mr. Hopps (left) demonstrates the operation of the air cooler.

Research into effects of cold air on persons suffering from certain forms of coronary disease and also on asthmatic subjects is currently being conducted at the National Defence Medical Centre in Ottawa.

A specially-designed respiratory air cooler was built for such research purposes by the Medical Electronics Group of Radio and Electrical Engineering Division of the National Research Council.

The apparatus is being used to investigate whether cold air inhalation may be a possible diagnostic procedure in the detection of these types of cardiac and pulmonary diseases.

The air cooler was designed at the instigation of Wing Commander G.M. Fitz-Gibbon, chief of the cardio-pulmonary unit of the National Medical Centre.

The cooler uses the heat absorption properties of liquid carbon dioxide when expanded from a high pressure state to produce large volumes of very cold air.

Subjects, depending on the nature of the study undertaken, either take the cold air directly by mouth from the machine via a hose mounted in the centre of the machine's frontal plate, or place their face close to the hose and allow cold air to play over chosen facial areas.

The cooler operates basically in this way:

Intaken warm air is blown through a helical coil of copper tubing housed in a sealed insulated cylindrical container, cooled in a carbon dioxide spray and exhausted through an insulated breathing hose. Liquid carbon dioxide enters the insulated chamber through a closed end copper tube which passes through the centre of the copper coil. The liquid gas is released through eight holes in the copper tube and exhausted through a large port via rubber piping to a fume chamber.

J.A. Hopps, head of this group, says it is possible to produce a differential in air temperature of 60 degrees centigrade. At

its low range of -40 degrees, temperature stability is within plus or minus two degrees.

Dr. FitzGibbon says the cooler has admirably fitted his original need of a small machine to produce large amounts of very cold air to study the mechanism of production of the anginal chest pains which coronary artery disease patients frequently experience when walking in the cold, particularly in the face of a breeze.

Angina pectoris - a strong sudden attack of pain in the lower part of the chest caused by narrowing of the vessels taking blood to the heart - has been noted to frequently occur in susceptible subjects when walking out of a warm building into cold winter air.

Most popular of a number of theories on the cause of this phenomenon suggests that a nervous reflex triggered by cold air striking certain parts of the body, notably the face, results in constriction of coronary arteries.

Within recent years, however, it has been demonstrated that inhalation of cold air can result in the appearance of electrocardiographic abnormalities in subjects with coronary artery disease.

Dr. FitzGibbon said attempts have been made using the respiratory air cooler to produce chest pain or electrocardiographic abnormalities in suitable subjects by cold air inhalation and by blowing cold air over their face, particularly in the region of the upper lip where it is suspected the cold trigger areas are situated.

"But, in the course of this work, a requirement arose to study an asthmatic patient who complained of particular difficulty in breathing out of doors in cold weather.

"Realizing there was at hand a suitable machine for producing cold air, a test consisting of the measurement of forced air flow rates in the bronchial tree before and after breathing cold air for five minutes was devised."

Dr. FitzGibbon said the bulk of the tests with the respiratory air cooler has involved pulmonary cases. To date there have been 200 such test cases.

"It has been demonstrated that the inhalation of cold air can significantly decrease air flow rates, particularly in certain asthmatics - probably by producing constrictive spasm of the smaller airways in the lungs," he said.

Dr. FitzGibbon noted that compiled data have not yet been analysed but said an initial report of his unit's studies should be available within a year.

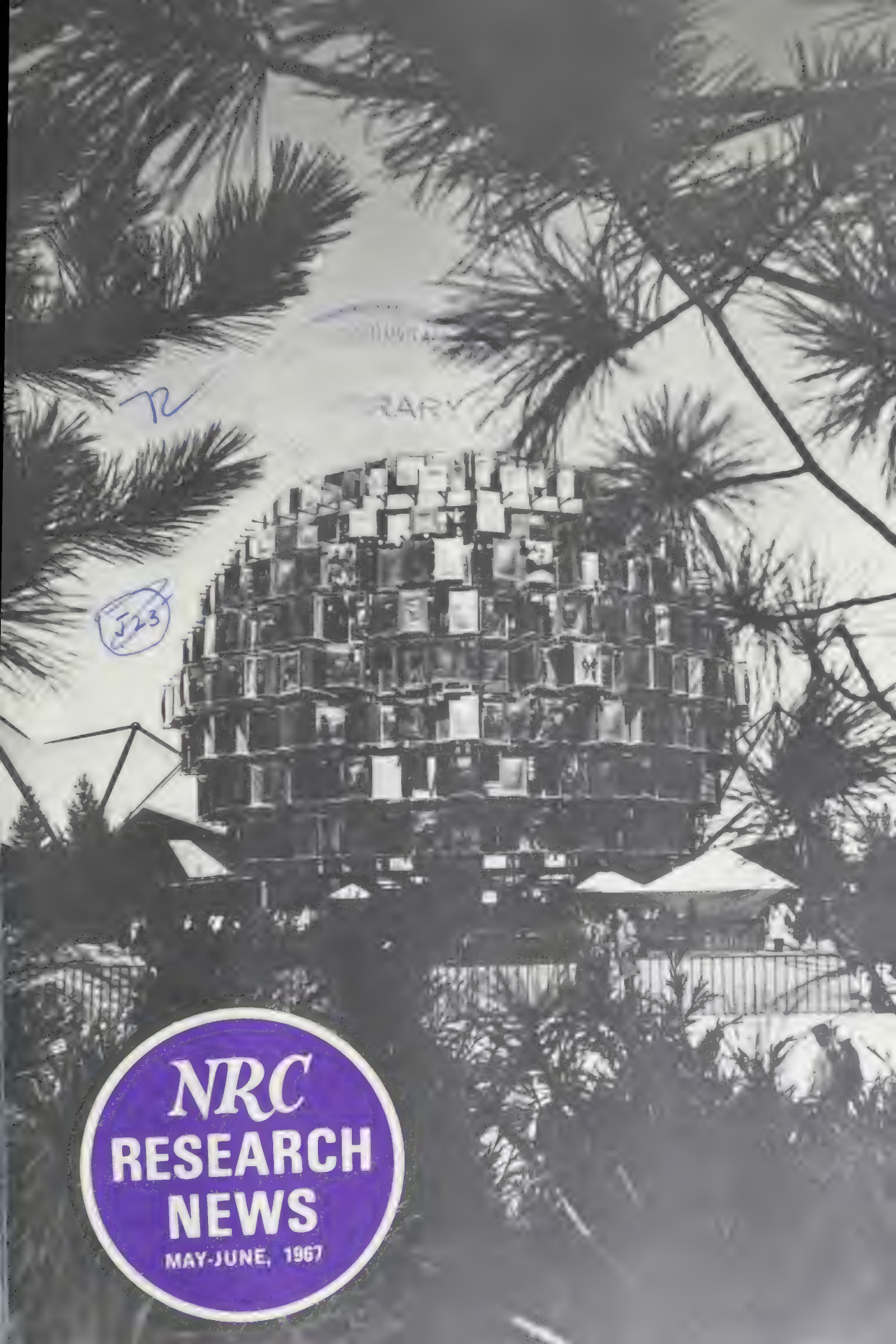
Appointments – Awards

Dr. B.G. Ballard, President of the National Research Council, received an Honorary Doctorate of Laws Degree, on April 14 from Strathclyde University, Glasgow, Scotland. The degree recognizes Dr. Ballard's contributions in the field of electrical engineering and radio research.

Dr. Alexander E. Douglas, a physicist, was appointed Associate Director of the Division of Pure Physics of the National Research Council, effective April 1. Dr. Douglas is head of the Spectroscopy Group in the Division and will continue to hold this position.

Dr. Olivier Heroux, a biologist, was appointed Liaison Officer of NRC's International Relations Office in Ottawa, effective April 1. Dr. Heroux previously was with the Animal Physiology Section of the Division of Biosciences.

Dr. Peter J. Krueger, a visiting scientist with NRC's Division of Pure Chemistry, was awarded the 1967 Coblentz Society Award during the first week of March. This prize is awarded annually to a scientist under the age of 35 for outstanding contributions to chemical spectroscopy.



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Cover: "People Tree" at Expo 67. See page 16.

Sizing up Quasars

A scientific first has been scored by Canada in research into quasars, the mysterious objects in deep outer space which radiate extraordinary amounts of energy.

A team of radio astronomers from the National Research Council; the University of Toronto; Queen's University, Kingston; and the Department of Energy, Mines and Resources has developed a new technique which has been used to determine the angular diameter of quasars.

This technique, which uses radio telescopes operated by NRC, the Penticton Observatory and the Defence Research Board, was proved out in a series of tests in May, 1967. First results of the tests show that some quasars have even smaller diameters than astronomers have been able to determine to date.

NRC's Algonquin Park radio telescope.

The control console of the Algonquin Park radio telescope.

The disclosure of the new technique was made by Dr. J. L. Yen of the University of Toronto at the 1967 Spring meeting of the International Scientific Radio Union. The four-day meeting was held at the University of Ottawa.

Dr. Yen's associates in the research project included N.W. Broten, Dr. T.H. Legg and Dr. J.L. Locke, radio astronomers at NRC's Algonquin Radio Observatory in Ontario's Algonquin Park; Dr. R.M. Chisholm of Queen's University; Dr. J.A. Galt of the Radio Observatory at Penticton, B.C.; C.W. McLeish and R.S. Richards of NRC's Radio and Electrical Engineering Division, and Dr. H.P. Gush, formerly of the University of Toronto and now with the University of British Columbia.

Quasars are regarded as one of the most exciting recent discoveries in astronomy. They were first discovered in 1960 and since that time some 200 have been identified.

Radio and optical astronomical measurements show that quasars radiate huge quantities of energy equal to that of a typical galaxy containing billions of stars. Yet quasars are apparently of star-cluster size, mere specks compared with average galaxies.

One of the foremost challenges in astrophysics is to understand how these small objects, billions of light years distant, can be the source of so much energy. One of the facts that must be known in making this assessment is the diameter of quasars.

The diameter of a radio source is ordinarly measured by means of a radio interferometer or radio telescope with two antennae and two receivers. Measurement and comparison of signals from the source received simultaneously by the two receivers enables astronomers to determine diameters.

To measure the very small diameters of quasars a very long baseline — the distance between the two antennae — is required. However, the operation of a conventional interferometer system with a baseline longer than about 100 miles is impractical because a link between the two receivers is required, either by a cable or a microwave system, both of which would be costly. There also is no assurance that such a system would be practical.

The Canadian team has developed a technique which removes the necessity of a direct link between the two receivers. It involves the recording of radio signals received from quasars simultaneously by the two widely separated receivers on magnetic tapes which are synchronized to a fraction of a microsecond — a millionth of a second — for the duration of an observation lasting up to an hour or more. This timing accuracy is achieved with synchronized atomic clocks at each telescope where the quasar signals are recorded on the magnetic tape.

The tapes from each radio telescope are brought to a central point for examination, eliminating the need for a direct cable or microwave link between the two receivers or telescopes.

In the tests, the team used NRC's 150-foot radio telescope at Algonquin Park, the 84-foot telescope at Penticton and a 60-foot radio telescope operated by the Defence Research Board at Shirley Bay, outside Ottawa. The distance between the Algonquin Park telescope and the one at Penticton is about 2,000 miles, and the distance between Algonquin and Shirley Bay is 115 miles.

The Algonquin Park—Shirley Bay study showed that many quasars must be smaller than 0.3 seconds of arc.

One of these sources — 3C273B — was also studied with the much longer baseline between Algonquin Park and Penticton. This examination showed that the kind of information required to put an even lower limit on the size of 3C273B had been recorded with this longer baseline.

These observations enabled the team to reduce the diameter of 3C273B, believed the nearest of the quasars, to less than .02 seconds of arc.

To determine the physical size of 3C273B from these angular measurements, it is necessary to know the distance of this quasar. If its distance of one and a half billion light years (as determined from optical measurement) is correct, the new radio measurements imply that 3C273B is no greater than 100 light years in diameter. Normal galaxies are about 100,000 light years in diameter.

The advantage of the Canadian technique is that the length of the baseline can be increased without difficulty to perhaps 10,000 miles measured over the earth's surface. Thus, if quasars are smaller than this new estimate, it should be possible to set even lower limits on the diameter using longer baselines.

This powerful technique opens the door to a great deal of original and promising research in the study of quasars. Results of these studies should provide further knowledge on the physical structure of quasars and this might be an important key to the evolution of the universe itself.

The Dominion Radio Astrophysical Observatory's radio telescope at Penticton, B.C.

Mr. Tanney observes interplay of fluid jet streams through window of flow visualization water tunnel.

Using fluorescent dyes, ultraviolet lighting, special camera techniques and a flow visualization water tunnel, researchers at the National Research Council are doing fundamental work in one of the newest of technologies — fluidics.

Studies are being undertaken by the Low Speed Aerodynamics Section of the National Aeronautical Establishment by a small team of researchers under the direction of John W. Tanney.

Fluidics was launched nine years ago after the first pertinent application was made of a phenomenon known as the "Coanda Effect." This is the tendency of a submerged jet of fluid, such as a gas or liquid, to attach itself to a wall adjacent to itself.

The first practical application, a U.S.-designed fluid amplifier, was the forerunner in a series of developments which indicates that flowing gases or liquids of fluidic circuits or devices can be made to perform many of the tasks now performed by charged particles of electronic circuits.

In size, fluid-operated devices range from complex circuits smaller than a fingernail to ducts large enough for a man to walk through.

Fluidics uses a fluid with low energy to control a fluid with higher energy. It is done through the interaction of flows and pressures in different components. The principles of hydraulics and pneumatics can be duplicated in fluidics. Pressure applied at one point in a system results in higher pressure at another point. A variation in input velocity, position, temperature or acceleration of the fluid at another point in the system is converted to fluid signals at other points that apply force, amplify energy or switch fluid energy.

With no moving mechanical parts, fluidics is considered to have an advantage over electronics where the need is for sensing, control or computing devices which must be economical, rugged and highly reliable. This is particularly true whenever the speed-of-light response of electronics is not needed. Fluidic devices can operate up to the speed of sound.

Potential applications are wide, including stabilization and control of missiles and aircraft, fuel control for aircraft engines, biochemical devices, automatic control of industrial machinery and the measurement of difficult quantities such as the low velo-

cities of air drafts in rooms or of currents in lakes.

Fluidic elements and systems have already been used to control everything from missile flights to assembly line production of wrist watch bands. It is already a $20,000,000 industry in North America and growth is so fast that this is expected to reach $250,000,000 by 1970.

With National Research Council assistance, a Montreal company, Aviation Electric Limited, has managed to carve out a place for itself in the field of fluidic controls.

National Research Council and AEL have, over the past three years, collaborated in fundamental fluid control studies and basic element design. Some of the model studies in liquid have been performed at the Low Speed Aerodynamics Section of NAE.

At NAE, the basic research tool is the fluid visualization water tunnel. In it, large-scale transparent models of fluidic devices are used with water as the working medium. Transparent dyes and ultraviolet lighting allow researchers to superimpose one liquid flow on another and to study and record the complex flow patterns.

"We have concentrated on understanding the flow in fluidic devices and are deeply involved in the techniques of flow visualization—still more an art than a science," says Mr. Tanney.

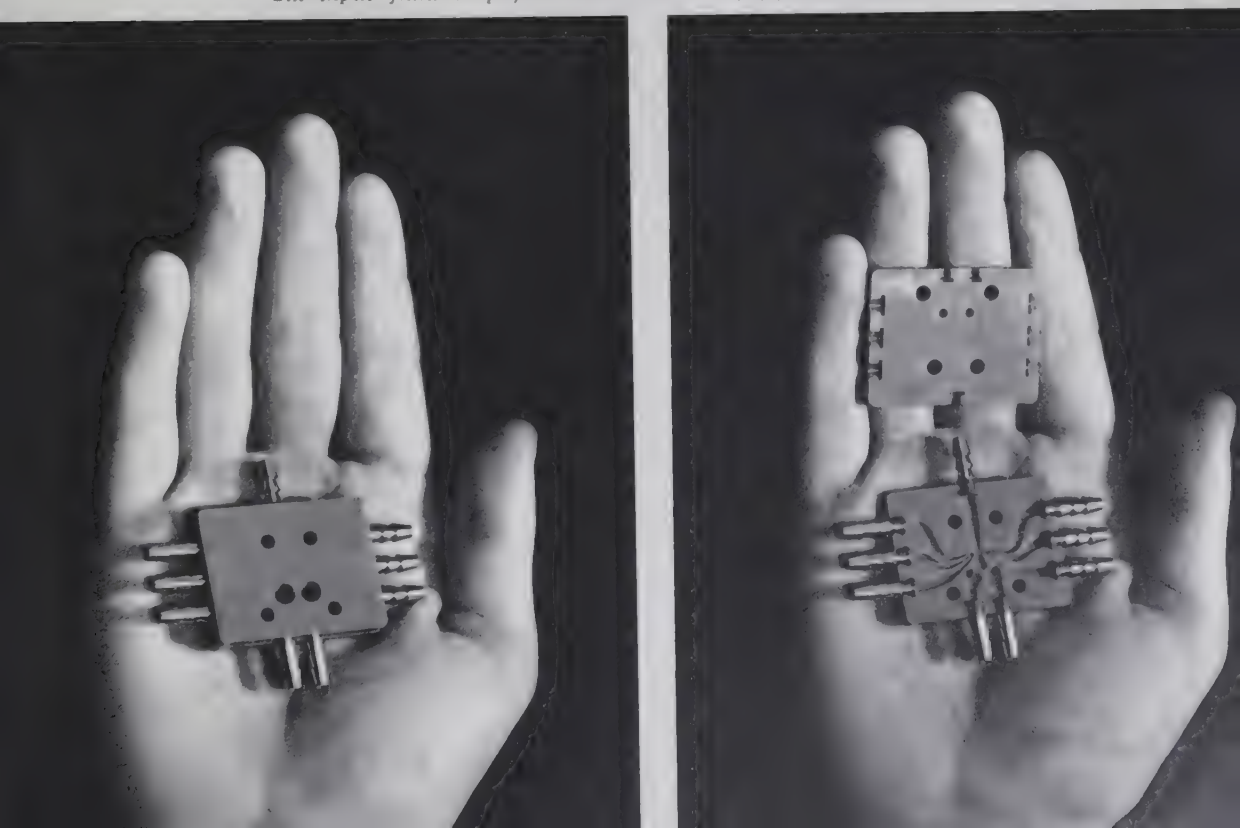
Mr. Tanney says the arrangement with AEL has been a successful one. "We left the engineering to them and concentrated on supplying them with technical assistance and information, as well as providing the use of laboratory facilities.

"With four devices on the market and others at varying stages of development, AEL is successfully meeting competition from U.S. firms in the U.S. markets", he observed.

The joint program has, in the past, been mainly directed toward gas fluid devices. Research programs involving laminar-flow devices (no turbulence) are now under way at NAE. Aim of the research is to develop low-noise devices with high performance characteristics — an area in which little prior work has been done.

A byproduct of the laboratory research at NAE has been the development of a flow-velocity sensor with a pressure output directly proportional to velocity. This makes possible the detection and measurement of speeds as low as one-tenth foot per second in air and one-hundredth foot per second in water. A Toronto firm, Champlain Power Products Ltd., has been licenced to manufacture this device. The sensor has been patented by Canadian Patents and Development Limited, a subsidiary of NRC.

Six input fluid amplifier with cover on (left) and cover off (right).



New Navigational Aid

Radel II approaches shore transmitter of Split-Beam Microwave Beacon.

In the early 1950's, National Research Council scientists came to the aid of small ship owners whose vessels were too small to take advantage of radar.

They developed the Microwave Lighthouse, a simple and inexpensive microwave aid to navigation. It consisted of a transmitter and antenna, installed ashore, radiating a beam of energy in the sector necessary for navigation and a portable shipboard receiver capable of determining the bearing of the transmitter accurately.

The shipboard operator donned earphones to listen for the signal needed to guide him through narrow water channels or into harbor through fog.

Unfortunately, ship pilots objected to wearing earphones while on the bridge attempting to bring their ship safely home in bad weather.

Main complaint was that this extraneous sound source interfered with their ability to hear and interpret natural sounds of potential disaster such as foghorns or waves breaking on shore.

To overcome this disadvantage, a new version of the Microwave Lighthouse is being developed by the Navigational Aids Section of the Radio and Electrical Engineering Division. This project is under the direction of L. G. Cox.

Called the Split-Beam Microwave Beacon,

it works in essentially the same manner as the Microwave Lighthouse except that guidance is given ship operators by sight rather than sound. Earphones and audible signals have been eliminated in favor of a receiving unit equipped with an electrical meter course indicator.

The new system of ship guidance was developed by NRC as the result of a brief submitted to the Royal Commission on Pilotage by Computing Devices of Canada Ltd. in 1964. This brief proposed that a microwave system with a visual meter course indicator would provide accurate guidance in bad weather of ships in narrow river channels, such as are encountered in the St. Lawrence Seaway.

The most critical conditions on the St. Lawrence Seaway exist when channel buoys have been lifted for winter.

At such times, rain, fog or snow will blank out the range lights on shore that are the primary aid to navigation. In bad weather radar becomes of limited assistance once the buoys have been lifted. Drifting ice packs produce radar echoes that confuse the actual radar picture of the shoreline, thus blinding the ship pilot.

NRC's Navigation Aids Section started work on the Split-Beam Microwave Beacon in 1964.

Tests, using NRC's research ship, Motor Vessel Radel II, were conducted on the Ottawa River in 1965 and in 1966. Final tests are to be carried out on the St. Lawrence this summer.

The new navigational aid has been patented by Canadian Patents and Development Ltd., a subsidiary of NRC. Computing Devices has been granted a licence to produce the beacon and will be testing pre-production models this summer.

The shore station comprises a split-beam microwave transmitter. The small-battery-operated receiver is designed to be hand-carried on board the vessel by the pilot. It uses a small horn antenna with crystal detector clamped to the side of the wheelhouse or any other convenient location.

The receiver compares the strength of the two beams received and displays their relative strengths on a centre-zero-meter.

If both signals are of the same strength, the meter needle will centre. If one signal is stronger than the other, the meter is deflected to the stronger beam, indicating the ship is off course. The amount the meter needle moves indicates the degree off course. A two-degree shift in ship's course will cause a full-scale needle deflection.

According to Mr. Cox, tests on the Radel — with the wheelhouse blacked out — showed that, with the beacon and ship's compass, it is possible to hold the ship within plus-or-minus one-quarter of a degree of true course (plus or minus 50 feet at two-mile range).

While its primary function should be as an aid in winter inland waterway navigation, Mr. Cox expects it may also find work on ships doing hydrographic studies. Hydrographic ships must maintain a fixed course while making depth soundings in uncharted water.

H. R. Smyth, Head of the Navigational Aids Section of REED, uses Split Beam Microwave Beacon's meter course indicator to keep Radel II on true course.

National Science Library

Mrs. Majorie Meleghy and Dr. Jack E. Brown, Chief Librarian of the National Science Library, examine the first copy of the computer-prepared "Union List of Scientific Serials in Canadian Libraries." It records holdings of non-book scientific literature in Canadian libraries.

A commercial telecommunications network is helping the National Science Library keep Canada's scientists, engineers and industrialists abreast of the latest scientific research and industrial developments.

The Library, a division of the National Research Council, has a collection of more than 600,000 books, bound periodicals, pamphlets and technical reports. This collection, together with material in other federal libraries in Ottawa, constitutes one of the world's finest collections of scientific and technical literature.

The Library is linked via Telex with more than 100 other university, government and public libraries, as well as 1,700 private firms in Canada. Outside Canada, Telex linkage through agreements with telegraph companies puts the Library in touch with major libraries and other information centres throughout the world.

The National Science Library is more than a library in the conventional sense of the word. It is primarily an information transferral agency with the responsibility of ensuring that existing technical and scientific information is available to any Canadian scientist, engineer or industrialist on a moment-to-moment basis.

Telex is one means to this end. Telephone and postal service are others.

Each day the Library answers an average of 300 requests for photocopies (photostats, microfilms, Xerox copies) of scientific and technical publications. Approximately 50 per cent of the requests are from industry. In the course of a year, the Library's Information Service also handles more than 12,000 information queries and information searches.

Libraries and other information centres have been the heavy users of the Telex service since it was installed in the Library two years ago.

"For speed and reliability on specific information requests, Telex is generally superior to the telephone or mail service," says Chief Librarian Dr. Jack Brown.

"Canada's industrial community is only gradually becoming aware that they have a direct line to us — and indirectly to information sources around the world — through the Telex machine in their offices."

The Library's ability to aid industry is growing rapidly. During the last 10 years, its collection has more than doubled and now is expanding at a rate of 130,000 items a year.

The Library holds subscriptions to more than 15,000 journals, and purchases monographs, textbooks, abstracting and indexing services. These are supplemented by publications acquired through exchange agreements with scientific and technical societies in all parts of the world. The Library is also a depository for publications issued by such organizations as the International Atomic Energy Agency, the U.S. Atomic Energy Commission and by the U.S. Clearing-house for Federal Scientific and Technical Information. Publications from this latter agency are received in the form of microfiche and total more than 20,000 technical reports a year.

In order to cope with this bibliographical explosion, the Library has introduced mechanized techniques to facilitate the storage, organization and dissemination of information. Computers and related data-processing equipment are now used to prepare these bibliographies. A complete listing of NRC publications, together with subject and author indexes, is also produced at regular intervals through the use of a computer.

The Library currently is operating a selective dissemination of information program in the fields of chemistry and the biosciences.

The project, using an electronic computer, scans the titles of papers appearing in some 700 journals and provides a small group of scientists, at two-week intervals, with bibliographies covering their specific fields of interest. As the system is refined it will be applied to other areas of science and technology.

NRC operates the Library under authority granted to it in the National Research Council Act. Section 13 of the Act gives the Council power to "establish, operate and maintain a National Science Library."

Recently, NRC gave the Library the responsibility of ensuring that the world's literature resources in the medical and health sciences are readily available to Canadians working in these fields. The Library will serve as the national centre for scientific and technical publications in the medical and health sciences. This new Library function was recommended by a special committee made up of the deans of medical schools, medical librarians and representatives from the Medical Research Council and other appropriate agencies.

An up-dated listing of the bio-medical journals held by the Library will be prepared and distributed this year. The Library recently purchased 200 foreign-language medical journals as part of a special effort to obtain medical journals which other libraries will not purchase because of infrequency of use.

These are added to the Library's collection of more than 15,000 journal titles — 1,600 of which are bio-medical journals.

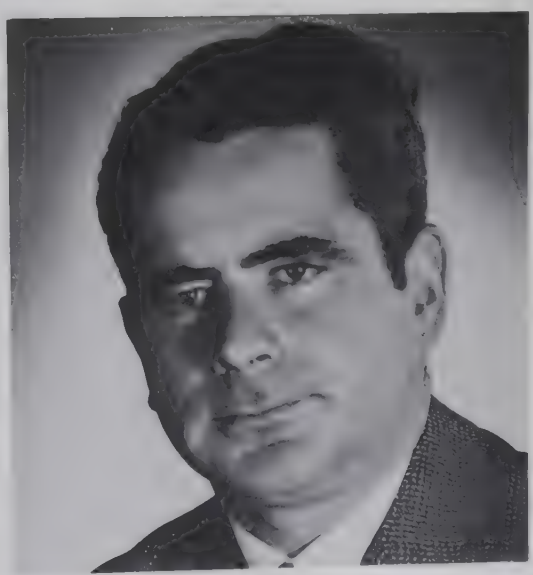
In order to assist in the use of foreign language publications, the Library maintains a Translations Section. Although limited to preparing translations requested by NRC scientists and scientists working under NRC grants, these translations are reproduced and made freely available to other scientists and engineers. An Index of Translations also records the existence and location of more than 200,000 English and French translations of foreign scientific papers which have been prepared in Canada and other countries of the world. Many of the translations so indexed are on file in the Library, while the others can be obtained by the Library upon request to the issuing organization.

It should be noted that the Library's services and resources are designed to reinforce and supplement local library information services, and not to supplant or replace them.

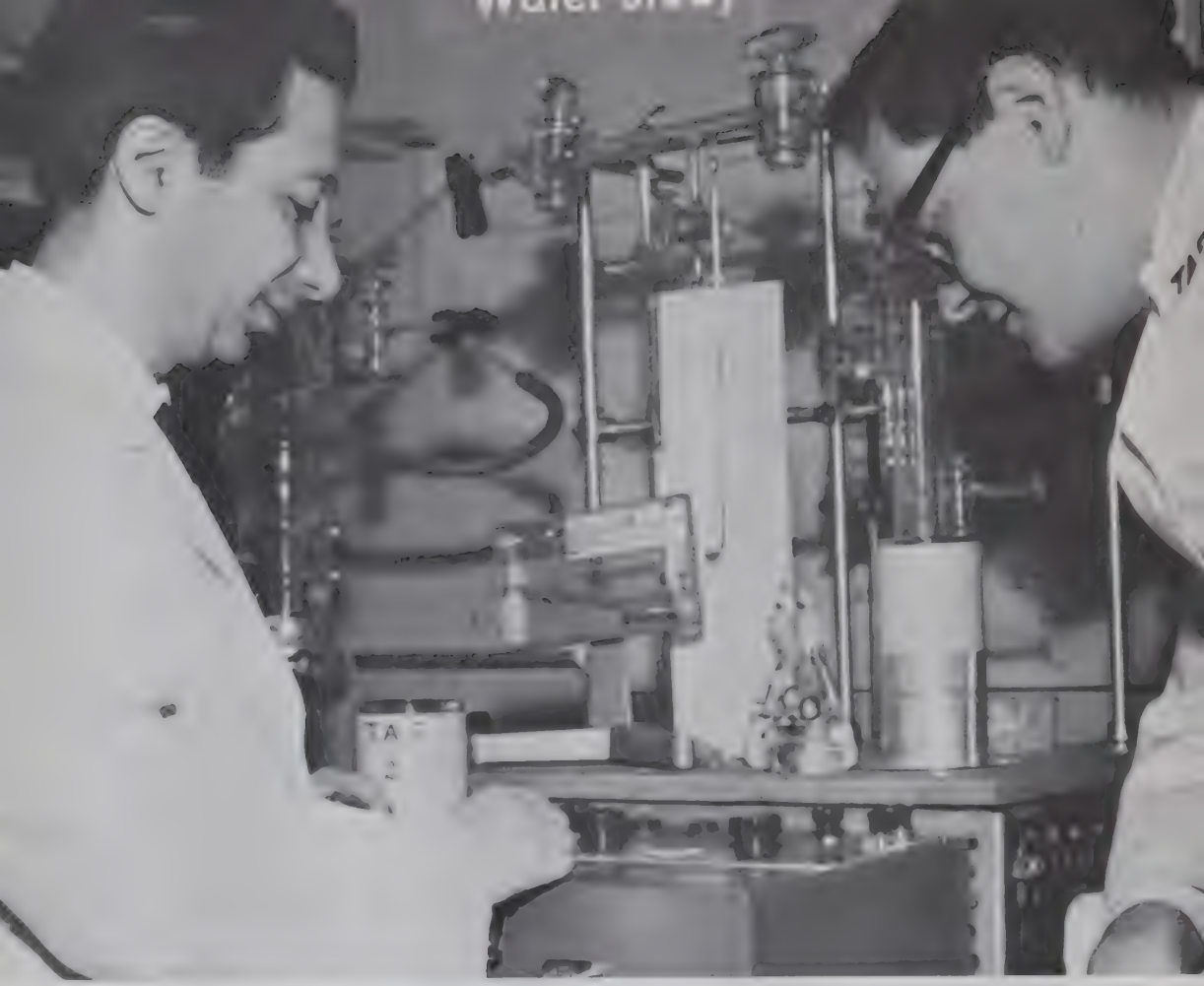
The rapid growth of the Library's functions and resources has necessitated the construction of a new Library building. Construction of this new building, to be located at NRC's Montreal Road site in Ottawa, will start in 1968.

Awards

Claude P. Lentz, Head of the Food Technology Section of NRC's Division of Biosciences, is the first recipient of the William J. Eva Award of the Canadian Institute of Food Technology. The new award in the field of food technology recognizes his work in developing and promoting the use of a jacket system of temperature control in refrigeration storage. The award was presented to him at the Institute's annual meeting in Montreal May 25, 1967.



Dr. David Makow, of the Photogrammetric Research Section of NRC's Division of Applied Physics, has received the 1966 Certificate of Merit of the Canadian Association of Radiologists. He received the Certificate for a paper entitled "Horizontal Laminography of the Head with Ultra-Sound," judged the best and most original paper published last year in the Journal of the Canadian Association of Radiologists. Dr. D. L. McRae, of the Montreal Neurological Institute, co-author, also received this award.



Dr. Falk (left) and Mr. Ford with the equipment they use in their study of the structure of water.

New insight into the internal structure of liquids has emerged from a fundamental study of hydrogen bonds in water at the Atlantic Regional Laboratory of the National Research Council in Halifax.

The study was conducted under the direction of Dr. Michael Falk of the Laboratory's Biophysics Section. He was assisted by T.A. Ford, a graduate student in the Chemistry Department of Dalhousie University who is working on a Ph.D. thesis under Dr. Falk's supervision.

NRC's Halifax laboratory is located on the campus of Dalhousie University. Under a plan worked out between NRC and the university, graduate students from the university undertake post-graduate research in the laboratory.

Mr. Ford is one of a number of such students who are conducting research under direction of laboratory staff members. He will be submitting his doctoral thesis to the Chemistry Department of the University this year. A part of the work on water will be included in the thesis.

In the water study, Dr. Falk and Mr. Ford used infrared spectroscopy to choose between conflicting theories regarding the nature of the bonds between water molecules.

Water, the most abundant of all liquids and also the most important, is made up of molecules composed of two atoms of hydrogen joined to one atom of oxygen. Such a small molecule would normally be expected to exist as a gas at ordinary temperatures rather than as a liquid. However, water is a liquid because the H_2O molecules tend to form bonds between one another. Such bonds are called hydrogen bonds and depend on the attraction of the hydrogen in one molecule to the oxygen in a neighboring molecule.

In ice, the water molecules are all joined to each other by a regular network of strong hydrogen bonds. However, when water is evaporated to form steam, the bonds between the molecules are broken and water becomes a gas.

The nature of the bonds between the molecules in liquid water has been a subject of dispute for some years. Some scientists support the theory that the molecules in liquid water are joined together in clusters with strong hydrogen bonds inside the cluster but with no hydrogen bonds between the clusters.

An alternative theory holds that the molecules in liquid water are still joined by a continuous network of hydrogen bonds as in ice, but the bonds are generally weaker and allow a movement of molecules with respect to each other.

Using infrared spectroscopy, which can measure the strength of hydrogen bonds, the following picture of the internal structure of liquid water has emerged.

In contrast to ice, in which each water molecule is joined to other water molecules by a regular network of hydrogen bonds of equal strength, the hydrogen bonds in liquid water form an irregular network and vary in strength. Some of these bonds are as strong as those in ice but most are weaker, and a few are almost completely broken by the thermal motion of the molecules.

The infrared spectrum allows the distribution of strengths of hydrogen bonds to be calculated and provides new information on how molecules are held together in water and in other biologically-important substances.

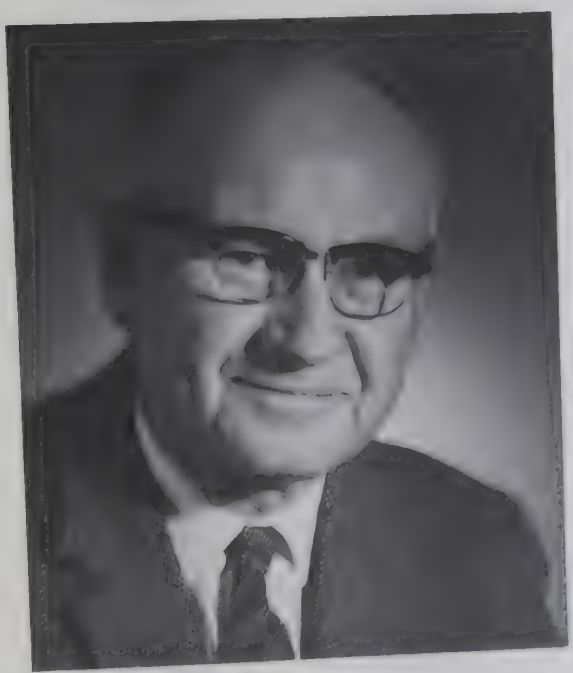
Dr. Falk said one aspect of the study involved the question of whether the physical properties of liquid water change smoothly with temperature or whether (as some scientists think) some discontinuities may occur at certain temperatures.

"This kind of question was recently examined by myself and Dr. George S. Kell of NRC's Division of Applied Chemistry in Ottawa. We found a smooth change of physical properties with temperature and no discontinuities.

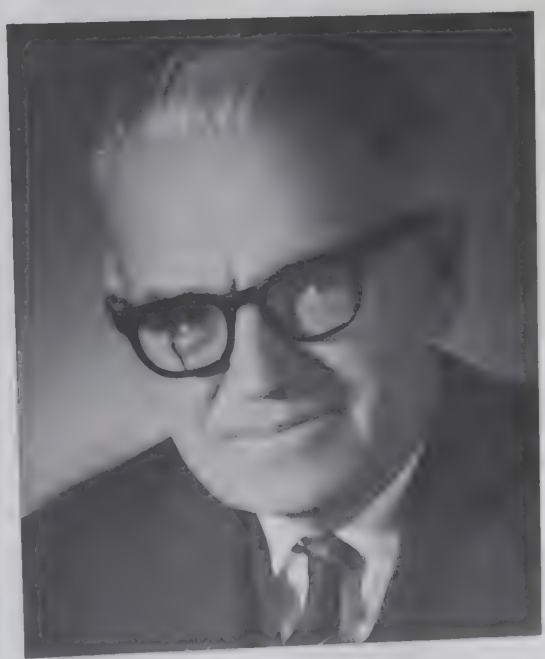
"This finding allows us to eliminate some of the proposed models for the structure of liquid water. These results were recently published as a collaboration with Dr. Kell," said Dr. Falk.

He added that the work on water had been helped by a recent study of the molecular structure of ice at low temperatures and high pressures carried out by Dr. Edward Whalley of NRC's Division of Applied Chemistry.

Awards



Dr. Ira E. Puddington, Director of NRC's Division of Applied Chemistry, was elected President of the Chemical Institute of Canada for 1967-68 at the Institute's 50th Canadian Chemical Conference and Exhibition in Toronto June 5, 1967.



Dr. Gerhard Herzberg, Director of NRC's Division of Pure Physics, received an Honorary D.Sc. degree at a special convocation of the University of Chicago May 5, 1967. The convocation marked the university's 75th anniversary.

Human Skill Studies

Pauline Theriault of the Control System Laboratory is shown being tested on stressalyzer. David Isnor, who sets up experiments for the instrument, examines the results of the test.

Large-scale experiments on human skill are being conducted by Dr. C. B. Gibbs in the Control Systems Laboratory of the National Research Council's Division of Mechanical Engineering.

Man-made control systems are used as analogies or models to provide insight into the central nervous system.

The performance of many extremely complicated systems such as aircraft, bulldozers and cranes is a function of the characteristics of the human operator combined with the characteristics of the mechanical system, and hence designers need to understand thoroughly the man-machine interaction.

The practical aims of the research include improvements in man-machine control systems and in training aids such as simulators. Preliminary investigations have led to the development of tests which help to detect potentially dangerous pilots or drivers.

An instrument known as a stressalyzer presents a tracking task in which the operator uses a handwheel to align a pointer with one of 5 target lights that are briefly lit in succession. Occasionally, the change from one target light to the next demands a tracking movement in an unexpected direction and it has been found that the time taken for an operator to react with a correct decision as to which way to move is about 0.4 seconds. Shorter reaction times normally are associated with a high occurrence of incorrect decisions and in consequence, movements start in the wrong direction.

The instrument can detect an individual's preference for speed or for accuracy in deciding on the direction of movement; and the speed and precision of controlling responses after the decision is made. Incorrect decisions contribute far more to accidents that imprecise movements but driving tests, for example, are based largely on estimates of the speed and precision of steering and braking movements.

A driver suspected of alcoholic impairment may be required to walk a straight line but in some individuals, the precision of walking is not noticeably affected by heavy drinking. Previous tests for impairment by fatigue were equally insensitive and ineffective. The stressalyzer test lasts only two minutes but it provides very sensitive measures of an individual's basic skill and of any deterioration due to stress which is induced by alcohol, sleep deprivation, etc.

There are great differences of ability between individuals and Dr. Gibbs considers that the most important use of the stressalyzer will be in selection, for example in determining whether a man's abilities exceed some minimum standard level that is specified for drivers or pilots. The same standard could be applied in all cases of suspected impairment due to stress.

The stressalyzer test showed definite impairment of skill at a breathalyzer reading of 0.05 per cent which can be produced in a 150-pound man by drinking two twelve-ounce bottles of beer. The same degree of impairment appeared in men whose breathalyzer readings had fallen to zero, some seven hours after they had stopped drinking—after reaching a peak reading of 0.1 per cent. Some men with a breathalyzer reading of less than 0.03 per cent performed worse than most other subjects with readings of about 0.1 per cent. Conversely, other men with a reading near 0.1 per cent performed better than most others when they were sober.

Tests were made of sober men who were kept awake for 48 hours. From 24 hours onward an increasing number became seriously impaired, although 10 per cent still performed well after 48 hours without sleep. Another group slept at night but was awakened at four-hour intervals and tested 15 minutes later. One third of the latter group performed very much worse than any of the men in the alcohol or sleep deprivation studies.

The tests also showed that the major effect of alcohol-induced stress on skill is to increase the time taken to react to an improbable, unexpected event. Moderate intoxication did not appreciably impair the ability to deal with familiar situations. The effects of sleep deprivation were similar. Most men compensated for the effects of stress by increasing the time taken to react but a small minority decreased this time with a consequent increase of incorrect decisions. Reactions of teenagers are usually more rapid and precise than those of adults but the former have less experience of improbable events. Their quick reactions are appropriate in familiar situations but inappropriate for unexpected contingencies. Dr. Gibbs stresses the important fact that accidents due to inexperience, alcohol and fatigue have a common basis in a preference for speed rather than accuracy in reacting to unexpected changes. This analysis facilitates the design of selection tests and training aids to detect and reduce a driver's undesirable tendencies.

The breathalyzer only determines the effect of alcohol on the breath and does not purport to measure behaviour or to detect the effects of many other forms of stress that may produce more impairment than moderate drinking. Dr. Gibbs feels there is a clear requirement for a large survey to estimate the distribution of different levels of skill in the population. A standard level of skill could then be set in granting licenses and for testing drivers suspected of impairment from any form of stress.

In the latest series of tests, the performance of subjects is recorded on magnetic tape and analyzed by a computer to produce an enormous increase in the rate of processing data.

Dr. Gibbs describes chart showing individual reactions to alcohol.

View of the "People Tree" at night

One of the eyecatchers at Expo 67 is the "People Tree" at the Canadian Pavilion.

The "Tree" is a six-storey-high structure carrying 1,500 nylon-fabric panels or "leaves", 500 of which are imprinted with photographs showing Canadians at work and play.

The Textile Chemistry Section of the National Research Council's Division of Applied Chemistry helped make this impressive exhibit possible.

Under the direction of C. H. Bayley, Head of the Textile Section until his retirement last year, several special investigations were carried out. These ensured that the dyes finally selected to produce the autumnal colors in the nylon "leaves" had good resistance to fading and would not cause light to weaken the nylon fabric prematurely, since the costs of labor and materials for frequent changing of 1,500 panels would have been impossibly high.

Then another problem arose. Certain properities of nylon made it the most suitable fabric for the "leaves", but, like most textile materials, it will burn if ignited. Thus the nylon "leaves" presented a possible fire hazard in the "Tree" with its structure of pedestrian ramps, stairways and interlocking platforms. With the co-operation of industry this problem, too, was solved, but not simply. It involved changes in the printing procedure, application of a special finish to the printed fabric, incorporation of strips of flame-resistant (but non-printable) fabric inside the hems, and the use of an expensive new sewing thread.

David M. Wiles, the recently-appointed head of the section, plans a gradual expansion in research on synthetic fibres and entry into fibre physics to find out what effect molecular structure has on fibre properties. He says this is a natural extension of the work done under Mr. Bayley.

Currently the section has five persons on applied work involving the evaluation of textile properties, development of test methods and serviceability evaluations. The four in the fundamental group are working on photodegradation, microbiological deterioration, and the mechanisms of degradation of fibre-forming molecules.

The "People Tree" problem was only the latest in a series successfully solved by the section. Other recent examples of applied phases of the work include: selecting the best fabrics for mailbags, assisting with the fading problem that plagued early days of the new Canadian flag, and comparing the effects of light on seat belt webbings made from a variety of synthetic fibres.

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Cover: Norman McPhee of NAE's Flight Research Section with "bird" containing magnetometer in foreground; North Star with tail "sting" in background.

Photo Credits: Trent University Studies by Andy Turnbull, Peterborough, Ont.; Dr. Marion by Capital Press, Ottawa; Dr. Woodward by Fabian Bachrach, Cambridge, Mass.; Dr. Puddington by Paul Horsdal, Ottawa; others by NRC.

Seek Earth's Secrets

High resolution magnetometer being towed in "bird" by NAE's North Star aircraft.

Scientists at the National Aeronautical Establishment of the National Research Council of Canada have converted an aging four-engined aircraft into a flying laboratory in order to probe for secrets hidden beneath the earth's surface.

Years of effort by aeromagnetic project engineers of NAE's Flight Research Section have gone into "marrying" a rugged North Star aircraft to a highly sophisticated instruments system whose heart is a pair of high resolution magnetometers. One is located in a 25-foot tail "sting" and the second in a "bird" capable of being towed up to 300 feet behind the aircraft.

The system makes use of the fact that all natural materials are magnetized to some degree and that some are sufficiently so as to cause distortion in the earth's magnetic field.

Housing the system in the North Star enables its operators to skim the earth's surface aboard an airborne platform, detecting, recording, mapping and interpreting such distortions. These can be caused by anything from a huge mineral deposit far underground to the magnetized hull of a submarine cruising just below the surface of the ocean.

Great things are foreseen for Canada as a result of the possibility of improved aeromagnetic surveying through use of the high resolution magnetometer system. There is high hope that these sensitive instruments will prove useful for oil surveying, because of their ability to detect changes in the structure or composition of the slightly magnetic sedimentary rock in which the oil is found. These small magnetic variations cannot be detected by the less sensitive magnetometer, according to E. A. Godby, in charge of the aeromagnetic research.

Mr. Godby said flight tests have been conducted to assess the advantages of high resolution aeromagnetic surveying over conventional methods and to see if these advantages make up for the added costs of high resolution aeromagnetic surveying.

In addition to the pair of magnetometers, the NAE system includes an analogue computer for inflight building up and testing of prototypes of special compensating devices such as are needed for airplane motion and for cancelling out the magnetic effects of the aircraft itself.

There is also a digital recording system which records the output of the magnetometers on magnetic tape along with navigational and other flight data of interest. All can be later fed into a digital computer at NAE's Uplands Airport base.

There is a digital readback system whereby data on tape can be instantly read back and checked for error so that operators can

Norman McPhee of NAE's Flight Research Section is shown assembling one of the orienting rubidium magnetometers.

be sure before they end their flight that their information is good.

Powering all these laboratory instruments is a big 60-cycle power generator.

Data from these devices are currently being used in the following research projects begun since acquisition of the North Star in 1962:

The application of high sensitivity magnetic methods to prospecting for oil and minerals. Some experimental surveys have been conducted over the Continental Shelf, Hudson Bay and in Alberta;

The investigation of ocean floor spreading from studies of the structure of the ocean floor as revealed by magnetic profiles taken over the mid-Atlantic and between Greenland and Canada;

The investigation of the magnetic variation caused by ocean waves and its use for wave measurement in oceanography. More of this work, which involves recording magnetic effects created by the motion of the wave itself, is to be done off Bermuda this winter;

The investigation of the effect of geomagnetic variations in the earth's magnetic field on high resolution magnetic surveys;

Experimentation with methods for automating the processes of producing aeromagnetic maps;

The utilization of high resolution magnetometers and improved data analysis techniques to reveal geological features which cannot be observed on the normal aeromagnetic maps.

This work is conducted in co-operation with, and is supported by the Department of National Defence and the Geological Survey of Canada.

The Defence Department donated the North Star to NAE in 1962 and now provides the six-man aircrew needed to keep it aloft during magnetometer work.

The Geological Survey of Canada gives geological and geophysics support to the operation. Its personnel participate in surveys and contribute to the analysis of data by use of computer. One GSC staff member devotes full-time effort to computer analysis of data taken from the magnetometers.

NAE became involved in aeromagnetics shortly after the end of the Second World War. In 1948, NAE's Flight Research Section was called on to install magnetometers in a Canso aircraft. In 1952 the Navy was investigating the use of magnetometers

John G. Waddell, also of the Flight Research Section, checks out recording equipment in the North Star aircraft.

Mr. Godby points to map showing a series of flight lines flown by the North Star aircraft during survey work over the mid-Atlantic ridge.

as submarine detectors for their Grumman Avenger aircraft and NAE developed techniques of compensation to cut out interference from magnetic sources in the aircraft itself.

They later provided assistance to the Navy and RCAF with regard to magnetometer installations in their Trackers, Neptune and Argus subkiller aircraft.

In 1962, after the military "fluxgate" magnetometers were declassified, this magnetometer was developed into a survey instrument having a resolution of two parts in one million of the earth's magnetic field. It was at that time a factor of 10 to 100 times more sensitive than the conventional aeromagnetic surveying instrument. This instrument was used for some special survey work in co-operation with DND and the GSC.

About this time also, magnetometry took a major leap forward when Varian Associates of Palo Alto, California, invented the optical pumping magnetometer which had a resolution 10 times better than the best Fluxgate magnetometer.

NAE acquired Varian magnetometers and used them for experimental purposes. They were used in magnetic profiling of areas in Canada's auroral zones, over the mid-Atlantic and in the Carribbean from 1963-67. However, they have certain disadvantages for airborne work and so a fully airborne magnetometer was developed by NAE using the basic Varian instrument.

An experimental model of this orienting rubidium magnetometer and an anomaly simulator are now being manufactured by Canadian Aviation Electronics of Montreal. The company was awarded contracts last spring by the Defence Production Department.

New Look for Journals

A "new look" is being given to the Canadian Journals of Research — an $850,000 scientific publishing enterprise operated by the National Research Council of Canada.

Changes in both format and in handling of editorial content will occur with the January, 1968, issues of the eight Journals devoted to publishing research findings in the basic physical and biological sciences: biochemistry, botany, chemistry, earth sciences, microbiology, physics, physiology and pharmacology, and zoology.

Dr. J. A. Morrison, Editor-in-Chief of the publications program, said the object of the changes is to improve the competitive position of the Journals in the scientific publications field. Currently, there are an estimated 30,000 scientific periodicals in circulation internationally.

"There is no place today for a parochial Journal," says Dr. Morrison, who sees increasing specialization as the means of making the Journals of Research good media for the publication of scientific papers in areas where first-class research is going on in Canada.

In the January issues, each Journal will have a clean, uncluttered two-toned cover in place of the mono-color of prior issues. Inside, a variety of changes has been made to improve "information retrieval" by the reader. The format has been changed from a one-column to a two-column layout and the pages have been made slightly wider and taller. This, in combination with a new type face, promises easier reading as well as greater economy of space.

In another change, white stock has replaced colored stock for the back cover, with a consequent increase in readability of the Table of Contents found there.

Part of the Journals' new look is provided by a new adhesive binding which makes each issue easier to handle.

The National Research Council of Canada has been in the scientific publishing business since 1929 when the first issue of the Canadian Journal of Research was published. Today, the eight Journals, with half of their 19,000 circulation coming from outside Canada, provide an international distribution for scientific information from Canadian laboratories and institutions.

During 1966, 2,289 articles were submitted for publication and 1,572 accepted. Of those published, 44 per cent came from Canadian universities, 27 per cent from outside Canada, nine per cent from NRC laboratories and 20 per cent from all other sources.

"The number of articles submitted to us is doubling every six years. This gives some indication of pressure being exerted by a steadily growing scientific community. As investment in scientific research grows, so will the amount of scientific work that needs to be published," said Dr. Morrison.

The Canadian Journal of Chemistry, that is edited by Dr. Morrison and Dr. C. T. Bishop, has served as a "guinea pig" in the longterm plan to develop attractive Journals specializing in certain research fields. In 1966 its frequency of publication was doubled to twice monthly with alternate issues carrying organic and physical chemistry papers. The Canadian Journal of Physics, currently the largest Journal, will follow suit in January.

Metallography Research

Multi-directional etch tunnels in polycrystalline aluminum magnified 36,000 times.

The American Society for Metals has given signal recognition to a National Research Council engineer for research in metallography. This is a branch of science which deals with the study of the structures and constitution of solid metals and alloys and the relation of this to properties, on the one hand, and manufacture and treatment on the other.

William Wiebe of the Structures Section of the National Aeronautical Establishment received the award for his entry in the Metallographic Exhibit at the October 16-19 National Metal Exposition in Cleveland entitled "Etch Tunnels in 2S Aluminium". The entry was awarded "Best in Class" in Class 11 on Electron Micrographs Using Replicas, and the award was accompanied by a medal.

Mr. Wiebe's entry consisted of two remarkable photographs of replicas of what are known as etch tunnels, along with textual material describing the photographs.

Etch tunnels, which give scientists information concerning the structure and constitution of metals and alloys, were produced by Mr. Wiebe on small samples of aluminum by an electropolishing method. A chemical and electrolytic process was used to obtain exact replicas of the tunnels in the form of a thin oxide film. The dimensions of the sides of the cross-sectional area of the tunnels at the level of origin varied from about 0.2 to 0.4 micron, decreasing to as little as 0.04 micron at the end of the tunnel. A micron is one thousandth of a millimetre.

Mr. Wiebe placed the oxide film sample on a grid and placed it in an electron microscope and magnified it 36,000 times. He then photographed the sample and obtained micrographs of the etch tunnels.

Turtle on the Trent

A scientific team from Trent University at Peterborough, Ont., is using an eight-ton floating mobile research laboratory in a concerted program of freshwater biological studies along the Trent waterway.

The studies along the waterway — a series of interconnected lakes, canals and rivers stretching from Lake Ontario to Georgian Bay — are being conducted under the direction of Professor Roy L. Edwards, Chairman of the University's Biology Department.

The floating laboratory was used during the summer of 1967 for an intensive study of the biological, chemical and physical characteristics of Clear and Stony Lakes, and a more extended study of the Trent Waterway from Balsam Lake to Rice Lake,

Dr. Edwards and Miss Maxwell study plankton in their floating laboratory.

including some work at night. These studies were concentrated mainly on plankton, the tiny animals and plants that form the basis of all marine life.

Professor Edwards says there is something more than scientific curiosity behind the studies. He says that the Trent Waterway is a tourist attraction that is becoming increasingly popular and like all such water systems is under a potential threat by pollution and eutrophication.

The laboratory's normal complement consists of five staff and students, with one person operating the vessel and the remainder undertaking research. The other research personnel are Professor Ian Sandeman, Christine Maxwell, David Lanesby and Larry Justus.

Professor Edwards co-operated with a naval architect in developing the design of the $15,000 floating laboratory. The National Research Council of Canada financed its construction by means of a major equipment grant. Operating costs are covered by the University, NRC and the Ontario Departments of University Affairs and Economics and Development.

The vessel, which has been named Turtle —abbreviation of Trent University Research and Teaching Laboratory — consists of a cabin supported on two pontoons each 40 feet long and eight feet square in cross section. The over-all length is 42 feet, the beam is 14 feet and draught is two feet. Powered by two 100-horsepower outboard motors, the laboratory has a top speed of 10 knots and a range of 50 miles.

The outside deck provides a working space from which water and plankton samples can be taken with special nets, and is equipped with a derrick for handling heavy equipment.

The rectangular cabin provides a 200-square-foot laboratory, with a high bench for chemical work along the starboard side, and a low bench with knee holes for microscope work along the port side. Each bench is fitted with double sinks and storage units. A small area at the stern is set aside for living quarters and includes two bunks, a closet and a dining table which converts into a third bunk. The chemically treated recirculating toilet system is connected to two 55-gallon holding tanks, so that no pollutants enter the lakes.

The vessel is wired for both 12-volt and 110-volt operation and carries its own generator. Scientific equipment includes microscopes, pH meter, absorptiometer, light meters, anemometer, and a recording echo sounder.

The vessel has proved easy to handle even in high winds, and as there is very little pitch or roll, all necessary scientific operations, except weighing, can be carried out while under way. This has resulted in a considerable saving of time, as samples can be processed on the spot. More extensive operations are being planned for the future, including co-operative work with other institutions.

Miss Maxwell and Mr. Justus collect plankton sample

Floating Laboratory on summer cruise.

BRAIN SCANNING MADE EASIER

As co-worker Brian Trollope plays the role of patient, Mr. Hudson demonstrates the ease with which one man is able to operate his alignment device. Transducers at temples of Mr. Trollope beam pulsed ultrasound and record returning echoes. Both are displayed on cathode ray tube screen, centre.

An alignment device that permits new and more accurate techniques for diagnosing certain brain disorders through the use of ultrasonics has been designed by the National Research Council of Canada.

The device, according to its designer Arthur Hudson, an engineer with the Radio and Electrical Engineering Division of NRC, is expected to make more simple and reliable the operation of A-scan echo-encephalography.

A-scan echo-encephalography is a term borrowed from radar to describe the method of presenting information gained via ultrasound on a cathode ray tube screen.

In general, this involves passing a beam of pulsed ultrasound of microsecond duration into the head in the temporoparietal region and recording the returning echoes. The transducer used to generate the ultrasound doubles as a receiver for the returning echoes which it converts into electrical signals for display on a screen.

It works on the principle that low intensity ultrasonic energy will propagate through living human tissue and when it encounters a new medium, some of the energy will be reflected. This reflection phenomenon is utilized for accurate location of hidden surfaces. The simplest way to achieve this is to transmit the energy in short bursts and measure the time required for the energy to reach and be reflected back from the unknown surface.

Echo-encephalography got its start in 1954 when Lars Leksell, a Swedish neurosurgeon first reported the use of pulsed ultrasound to reveal lateral shifts in certain structures which normally lie in the medial plain of the brain. Today, hundreds of hospitals throughout the world use Leksell's method as a clinical diagnostic technique for spotting various pathological conditions within the skull, notably haematoma following injury, certain brain tumours and hydrocephalus.

The drawback to A-scan echo-encephalography is that practitioners must be highly skilled — usually neurosurgeons — because achieving a reliable record of brain structures has always been a fine art.

An operator looks for evidence of a significant shift of the cerebral midline structures. Such a shift would be indicative of a local swelling of the brain which could, for example, be caused by a tumor.

It is generally agreed that the midline echo has the highest amplitude and is the most persistent of the echoes seen. What makes its amplitude and persistence unreliable as a sure means of identification is the fact that it could be confused with other high amplitude echoes sometimes seen on the screen.

According to Dr. D. Naldrett White, head of the Medical Ultrasonics Research Group at Queen's University, with whom Mr. Hudson has been in collaboration, the problem with A-scan echo-encephalography "can best be described as a surfeit of riches". An abundance of echoes can be obtained by any operator who places a transducer on a human skull — wherever he places it and at whatever angle he chooses. The question is: which echo comes from which surface?

To help combat this defect, Mr. Hudson has developed a transducer mount which has two principal functions: to place the two transducers in contact with the patient's head in essentially homologous positions; and to maintain this symmetry while the operator searches for an acceptable echo display.

The design allows the operator four degrees of freedom in his search for midline echoes. He may move or rock the transducers in both the coronal and horizontal planes without having to disturb the symmetry of their placement.

In conjunction with the alignment device, Mr. Hudson — in collaboration with B. J. Trollope of the same Division — designed and built a four-trace simultaneous presentation echo-encephalograph, believed to be the first of its kind in use.

On this instrument, the top trace on the screen represents the transmission of a sound pulse through the head from the left transducer to the righthand receiver. The bottom trace is another through-transmission, this time from right to left.

The two middle traces are echoes, the upper one being from the lefthand transducer into the head and reflected back to the same device acting as a receiver. The lower echo trace represents a pulse generated in the right transducer and reflected back into it.

In any case where the midline structures are not displaced, the midline echo peaks and the through-transmission pulses will show up on the screen in a vertical line because it will take exactly the same amount of time for a pulse to travel to the midline and back (in either direction) as for a pulse to go all the way through.

If the midline is displaced, the echo on one side will travel a shorter distance than the echo on the other side. Thus the two midline echoes will be shifted by an equal amount to either side of the line intersecting the transmission pulses.

An obvious advantage of this method is that it enables the operator to tell whether two echoes on the middle traces are coming from the same object. If, for example, the echo on one side was recorded from a lateral ventricle while that from the other side was reflected from the midline, this would be immediately apparent. In a normal brain the echo from the lateral ventricle would be displaced towards the transducer whereas the echo from the midline would be in line with the transmission pulses.

Early results suggest that echo-encephalographs taken while using this alignment device have a number of advantages over hand-held methods, according to Mr. Hudson.

"With the alignment device, unusual stability of the echo pattern is found. This allows the operator greater freedom to make minor adjustments to the receiving and display system without losing the significant echoes."

The most significant finding is that the alignment device, when used with the four-trace simultaneous presentation echo-encephalograph, calls for much less operator skill than does hand-held techniques.

Mr. Hudson feels that A-scan's comparative simplicity and low cost will make it greatly useful as a preliminary screening device.

Mr. Hudson points out that radiologists no longer take their own roentengrams nor neurologists their own electroencephalograms. "This development should help to place A-scan echo-encephalography on the same basis."

Assumes New Post

Dr. Cook

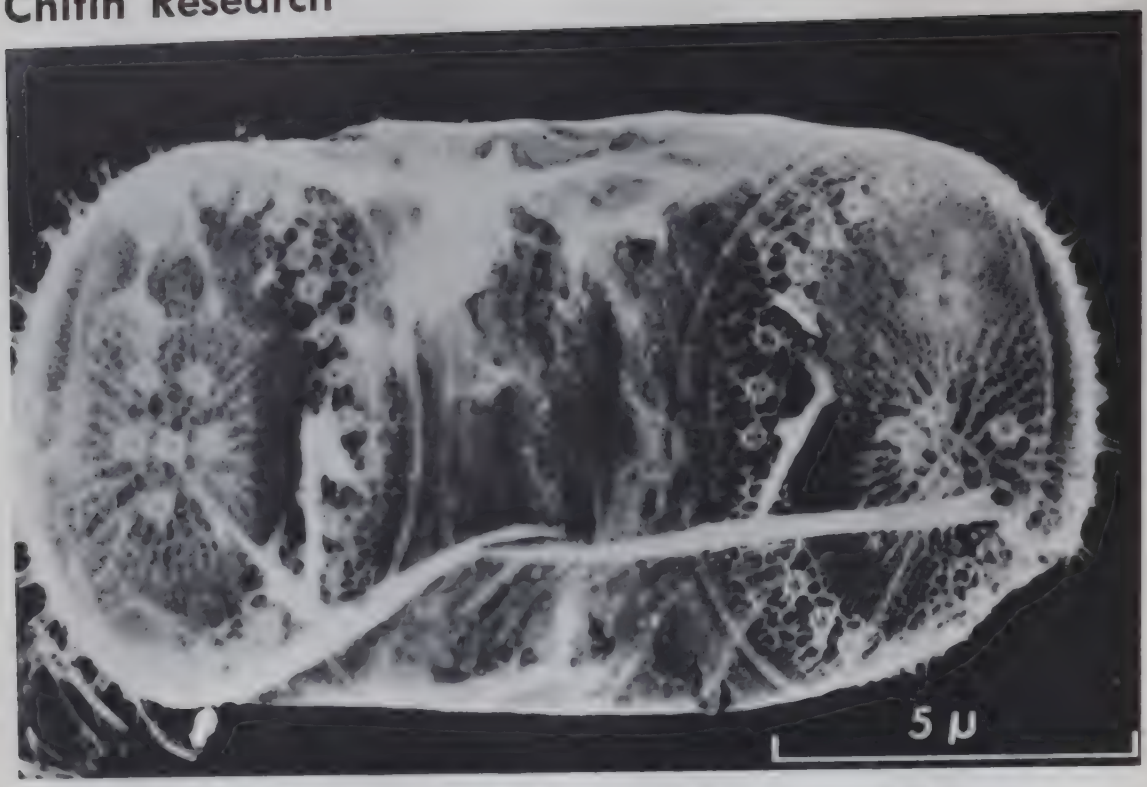
The National Research Council announces that Dr. W. H. Cook has been appointed Executive Director. Dr. Cook, currently the Director of the Division of Biosciences, will in his new capacity assume executive responsibility over several areas of the Council's activities, including the administration of the Council's Grants and Scholarships Programs.

Dr. Cook joined NRC in 1930 after graduating from the University of Alberta and working as a research assistant at that university for three years. He was appointed Director of the Division of Biosciences in 1941.

Born at Alnwick, England, Dr. Cook received his Ph.D. from Stanford University in 1931. He was awarded the O.B.E. in 1946 for distinguished leadership in wartime research during the Second World War.

Dr. Cook is a former President of the Royal Society of Canada and the Canadian Biochemical Society. He is a member of the Agricultural Research Institute of Ontario and the Board of Governors of the University of Guelph.

Chitin Research



The shell of a diatom (about one-thousandth of a centimetre in length) showing the round pores at its end through which the chitan fibres grow. These fibres grow outward to a distance of about eight to 10 times the length of the shell.

National Research Council scientists in laboratories at Halifax and Ottawa are probing the mysteries of chitin — after cellulose, the world's most abundant natural organic compound.

Until recently little was known about chitin (pronounced Kytin) despite the fact that an estimated one billion tons is produced and destroyed each year. Research was hampered by a scarcity of chitin in a pure form. Most chitin is found as a white, hornlike substance forming the outer coats or shells of insects, crustaceans and other invertebrates. In this form it is contaminated with a lot of extraneous materials such as proteins, salts and calcium carbonate.

However, a breakthrough occured five years ago when Dr. J. L. McLachlan, head of the Marine Botany Section of NRC's Atlantic Regional Laboratory at Halifax, began looking at properties and ecologies of some small marine plants.

One group of plants studied was the diatom, a one-celled alga with a cell-wall of silicon formed like a box and its cover.

Dr. McLachlan devoted three years of painstaking work to successfully isolating this tiny sea organism and then determining the conditions under which it would grow in culture.

In collaboration with Dr. A. G. McInnes, head of the Chemistry of Natural Products Section of ARL, Dr. McLachlan was able to show that these tiny diatoms extrude fibres 60 to 80 microns in length, much as a porcupine extrudes quills. These fibres proved to be absolutely pure chitin (in this form called Chitan) and in addition, were shown to be as crystalline as any other known biological fibre.

To determine the internal structure of these fibres, chitan samples were sent last year to the Biophysics Section of NRC's Division of Biosciences in Ottawa for examination by X-ray diffraction and electron microscope. This form of chitin was found to be water repellent and extremely resistant to attacks by acids, alkalis or enzymes.

Photographs with the electron microscope show that these fibres taper slowly at their base to a vanishingly small tip, much as a buggy whip tapers. The same photographs prove that these fibres are composed of still smaller filaments.

The outer tip of the chitan fibres taper slowly and uniformly to a point which is below the resolution of the electron microscope.

Films formed from these fibres proved extremely durable and resistant to most hazards with the exception of fire, according to Dr. J. Ross Colvin, head of the Biophysics Section.

Dr. Colvin said that there does not appear to be any immediate practical application of the chitan findings because great quantities would have to be produced and the techniques developed by Dr. McLachlan are complex and very painstaking. The fact that two major foreign laboratories have tried and failed to duplicate Dr. McLachlan's work while two others have been able to repeat his observations indicated that chitan production is as much an art as a science at this point, said Dr. Colvin.

He did hold out hope that the unusual properties shown by chitan could some day be put to commercial use. The fact that chitan is almost as durable as glass fibre yet, unlike glass fibres, can be consumed by fire, could be of considerable advantage.

Research is continuing both in Halifax and Ottawa.

NRC Pier Fellowships

The National Research Council of Canada has broadened its awards program of assistance to engineers and scientists from industry seeking research experience in government and university laboratories.

It has announced greater benefits to successful applicants for Post-Industrial Experience Research (PIER) Fellowships.

During a two-year trial period just ended, NRC offered $6,000 grants to successful applicants holding a minimum of a Master's Degree from a recognized university and having professional experience of at least two years in industry. Awards were for one year only.

Applicants for PIER Fellowships now need hold only a Bachelor's degree in science or engineering plus five years experience in industry to qualify. Grants will be $6,000 a year or $7,200 for a married man with children. Awards may also be renewed for a total of three years.

The fellowships will be tenable in science and engineering departments of Canadian universities or government laboratories. Fellows are expected to undertake research programs compatible with the program and research interests of the institute at which the fellowship is held.

The deadline date for receipt of applications for fellowships in 1968-69 is January 16th. Application forms and additional information may be obtained from the awards officers, National Research Council of Canada, Ottawa 7, Ontario.

NRC's Inflated Building

Tests will be conducted this winter by design engineers at the National Research Council of Canada to determine whether a huge pond used for ship model studies can be enclosed in an inflatable building.

Such a building would provide a controlled weather environment for this type of testing. It would be possible to keep the pond ice-free during Ottawa's frigid winters and would permit research to be conducted during other periods of bad weather.

The pond, measuring 400 feet by 200 feet, is used by the Ship Laboratory of NRC's Division of Mechanical Engineering to test scale models of newly designed ships. Simulated sea conditions are created in the pond with pneumatic wavemakers located along one of the pond's 200-foot sides and a wave absorber along the opposite side.

S. T. Mathews, Head of the Ship Laboratory, says full-scale research at sea with actual ships can be conducted satisfactorily under natural weather conditions. However, ship model research can only be carried out satisfactorily on a continuing basis in a controlled environment sheltered from natural weather conditions.

Under present conditions, the Ship Laboratory is unable to use the basin during freeze-up and during other periods of bad weather. This has created a serious problem because there is a continuing heavy demand by governments and industry for tests of new ship designs, especially the bigger and faster cargo vessels now going into service.

Studies will be made this winter to determine whether the pond can be enclosed in an inflatable building made of vinyl-coated nylon. The nylon material used in such buildings is spread out flat, anchored to the ground and then inflated with air at low pressure from blowers outside the structure.

One of these blow-up-like-a-balloon buildings, based on a design by the Central Design Office of NRC's Division of Mechanical Engineering, has been erected over the pneumatic wavemakers to protect them from the weather. Resembling a wartime quonset hut, it is 197 feet long, 36 feet wide and 18 feet high.

E. S. Moore, Chief Designer of NRC's Central Design Office, says the nylon material was purchased in the United States and fabricated into a shape specified by his office. Two electrically-driven air blowers are used to inflate the building and maintain inflation, and heat is supplied by two oil-burning heaters at each end of the structure. There also are two standby gasoline-driven blowers for use in event of an electric power failure.

Entry to the building is through a garage-type folding door. The amount of air escaping when the door is opened does not have any appreciable effect on the rigidity of the nylon structure. Auxiliary wooden arches erected over the wavemakers prevent collapse of the structure in event of a heavy snowfall.

"During the coming winter we will watch the building carefully to determine such things as the building's snow shedding ability, heat loss and condensation. By the end of the winter we hope to have sufficient information to determine whether the pond itself can be enclosed in an inflatable nylon structure," Mr. Moore says.

Mr. Moore says the structure over the pneumatic wavemakers and the blowers and heaters cost $17,000, a fraction of what would have been spent in erecting a wooden building. It would not have been possible to erect a steel-supported structure as the steel would interfere with the operation of telemetry equipment used in ship model research.

"If our tests show that it will be possible to enclose the pond in an inflatable building, we will be able at small cost to make available a major research facility on a year-round basis," Mr. Moore said.

Interior view of the inflatable building.

Léo Marion Lectures

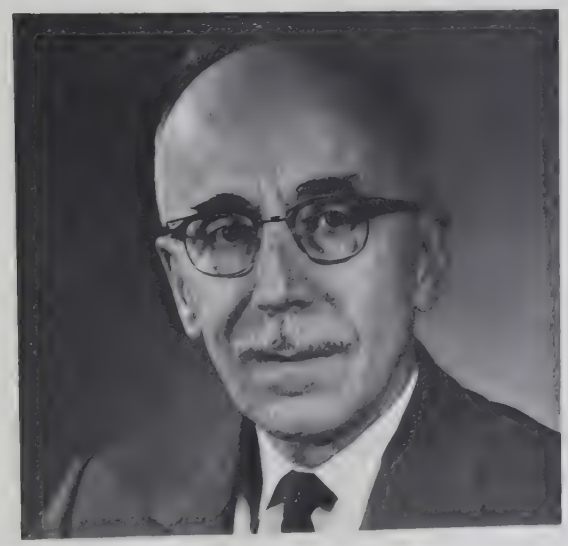
The Division of Pure Chemistry of the National Research Council of Canada in March, 1968, will inaugurate the Léo Marion Lectures, a series of lectures to be given annually over a period of one week. The first Lecturer will be the distinguished American organic chemist, Dr. R. B. Woodward of the Department of Chemistry at Harvard University.

The annual Lectures are named after Dr. Léo Marion, Dean of the Faculty of Pure and Applied Science of the University of Ottawa. Dr. Marion was a member of the scientific staff of NRC for 36 years. He was Director of the Division of Pure Chemistry from 1952 to 1963. At the time of his retirement from NRC in 1965, he was Vice-President (Scientific). His main interests now are academic ones, but he still maintains an affection for the scientific work of the Division of Pure Chemistry.

Dr. Woodward has received many honors for his outstanding scientific work, including the Nobel Prize in Chemistry in 1965.

Dr. J. A. Morrison, Director of the Division of Pure Chemistry, says it is particularly fitting that Dr. Woodward should be the first Lecturer because he and Dean Marion share common interests in the chemistry of natural products.

The 1968 Lectures will be given March 25, 26 and 27 in Ottawa in the Auditorium of NRC's Sussex Drive Building. The titles of Dr. Woodward's lectures will be announced later.



Dr. Marion

Dr. Woodward

APPOINTMENTS

AWARDS

Dr. R. N. Jones, Head of the Organic Spectrochemistry Section of NRC's Division of Pure Chemistry, was elected Secretary of the Task Group on Computer Use of the Committee on Data for Science and Technology, International Council of Scientific Unions.

Dr. G. C. Butler, Director of NRC's Division of Radiation Biology, was elected Chairman of the United Nations Scientific Committee on the Effects of Atomic Radiation for its 18th and 19th sessions.

Dr. Ira. E. Puddington, Director of NRC's Division of Applied Chemistry, was elected an Honorary Fellow of the Royal Australian Chemical Institute. He was also elected Secretary of the Applied Chemistry Division of IUPAC.

Dr. D. S. Clark, of the Food Technology Section of NRC's Division of Biosciences, was named a member of the Expert Advisory Panel on Food Hygiene of the World Health Organization for a five-year period.

Dr. F. T. Rosser, former Vice-President (Administration) of NRC, received the 1967 Gold Medal Award of the Professional Institute of the Public Service of Canada.

William L. Haney, Head of the Data Systems Section of NRC's Radio and Electrical Engineering Division, was appointed Liaison Officer in charge of NRC's London, England, office.

Harry Williamson, Liaison Officer in charge of NRC's London, England, office returned to Ottawa to assume the position of manager of the Canadian Journals of Research published by NRC.

NRC RESEARCH NEWS

JAN.-FEB., 1967

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Cover: NRC engineer Howard S. Fowler rotates strapped in the seat of his model compressor. He clasps a fixed, specially shaped clamp with his teeth to keep his head perfectly steady and prevent loss of orientation and dizziness.

Photo Credits: Seagulls by Vancouver Sun; Radar intensity codes by RCAF; Respirometer by UBC; Dr. Bader by Tom Bochsler; Dr. Dixon by UBC; others by NRC.

Bird Forecasting

Seaplane making landing on west coast encounters curtain of seagulls.

The National Research Council's Associate Committee on Bird Hazards to Aircraft is attempting to develop a system, using meteorological information backed up by radar and photography, for forecasting the penetration of concentrations of birds into the air space over airports and along air routes.

The Committee, with the co-operation of the RCAF and the Department of Transport, is developing a radar-photographic bird intensity forecast system as part of its wide-ranging program into methods of reducing the threat that bird strikes present to high-speed jet aircraft. Most air crashes and accidents attributed to bird strikes occur after a jet engine has ingested a bird or after a large bird has struck other parts of an aircraft.

The bird intensity forecast system was tested on a 24-hour basis during the spring and fall migration periods in 1966 at Canadian Forces Base, Cold Lake, Alberta. These periods were selected because the large numbers of birds crossing air routes and airports in the spring and fall create a major hazard to jet aircraft.

In the spring tests, the forecasts were valid 83% of the time. For August they were valid 70% of the time, and for September, 71%.

The forecasts, prepared twice daily by the Meteorological Forecast Officer, gave the expected intensity of bird movements for any given hour, in terms of a 0-8 intensity code. The information was given to the Flight Safety Officer and was treated like a special weather report. The influence of the report on the flight training program in progress depended on the degree of hazard presented by the forecast and the nature of the training program at a particular time.

Taking the intensity ratings 5, 6, 7 and 8 as high risk situations, only 119 out of 2068 hours monitored (6%) in the spring and fall tests fell in these categories. In September, the month of the greatest migration activity, about 10% of the recorded intensities were high risk hours. Most of these were between sundown and midnight, and very few during daylight.

The Cold Lake project involved the use of a standard 4″ by 5″ camera with an adapter to take polaroid film and a radar display capable of spotting bird flights within 50 miles of the base.

On request, or at predetermined intervals to prove the forecast, a time exposure of about 12 minutes was taken of the radar display and developed immediately. Bird echoes that may be rather indistinct dots on the display appear as lines on the film; these lines are created by the movement of the echo across the screen during the period of the time exposure.

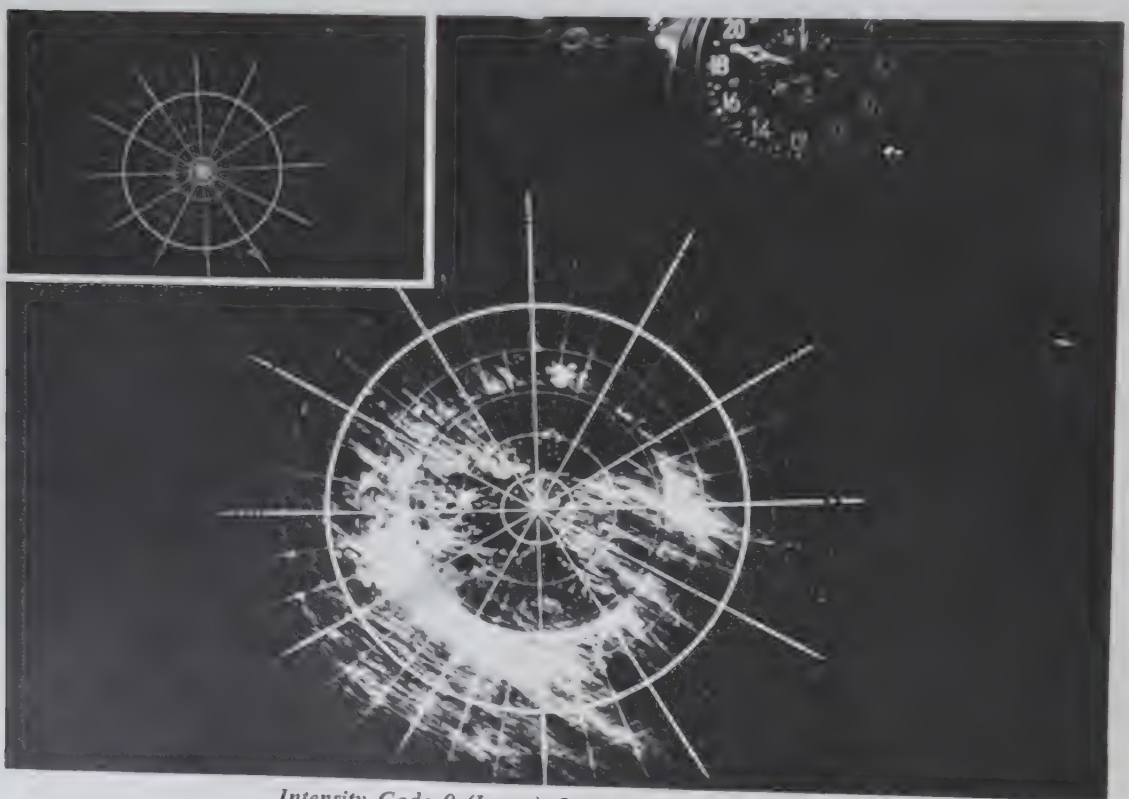
They are easy to see and identify as flights of birds and give an accurate picture of the intensity of bird movement as it appeared during the previous few minutes. Extent, direction, altitude and type of bird movement were not normally supplied but could be obtained by request from the radar scope photographers in regard to a current situation. This was sometimes done in a critical situation as for example when a flock of geese was moving through the area.

Where birds are a hazard, aircraft pilots can increase their margin of safety by treating them in the same way they treat thunderstorms. They can avoid areas known to be dangerous because of bird concentrations by circum-navigating or by over- or under-flying the areas of greatest intensity, or they can reduce speed to decrease the force created by a bird impact, if one should occur.

An example of the value of the forecasting facilities occurred September 26, 1966, when a number of night training flights were scheduled at the base. The Flight Commander asked for a bird intensity forecast for this period and was informed that it called for a sharp rise in intensity just after dark because the meteorological forecast called for northerly winds and clear skies, conditions judged favorable for migration.

The commander decided he would call off flights if and when the intensity reached grade six. This upper limit will depend on the type of flying being done, the species of bird involved because of weight and the urgency of the flying operation. He asked a photographer to stand by the radar and provide current intensity reports every half hour.

The bird intensity rating climbed rapidly after dark, soon approaching the six rating. Then, however, the wind shifted to the south and the sky became overcast. A decline in the bird intensity rating was reported and the training flights were completed without interruption.



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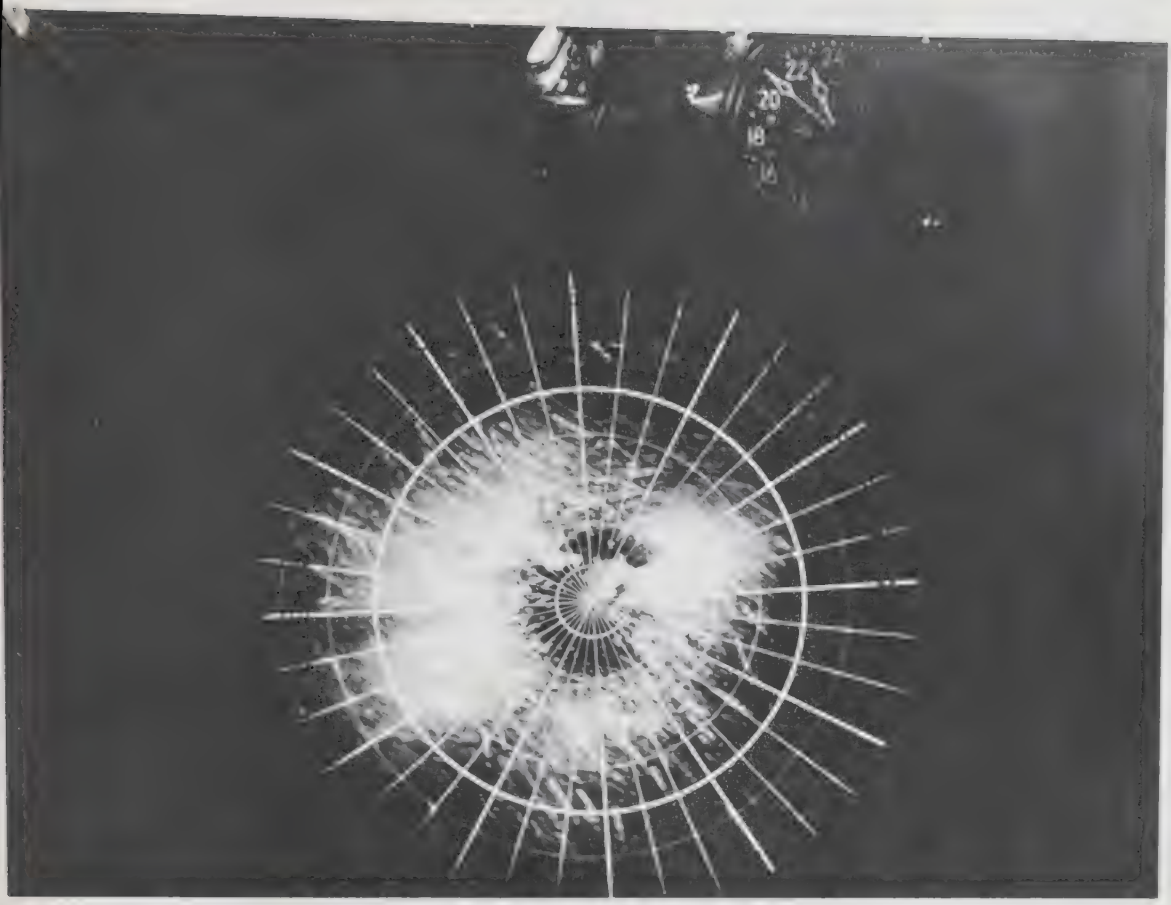

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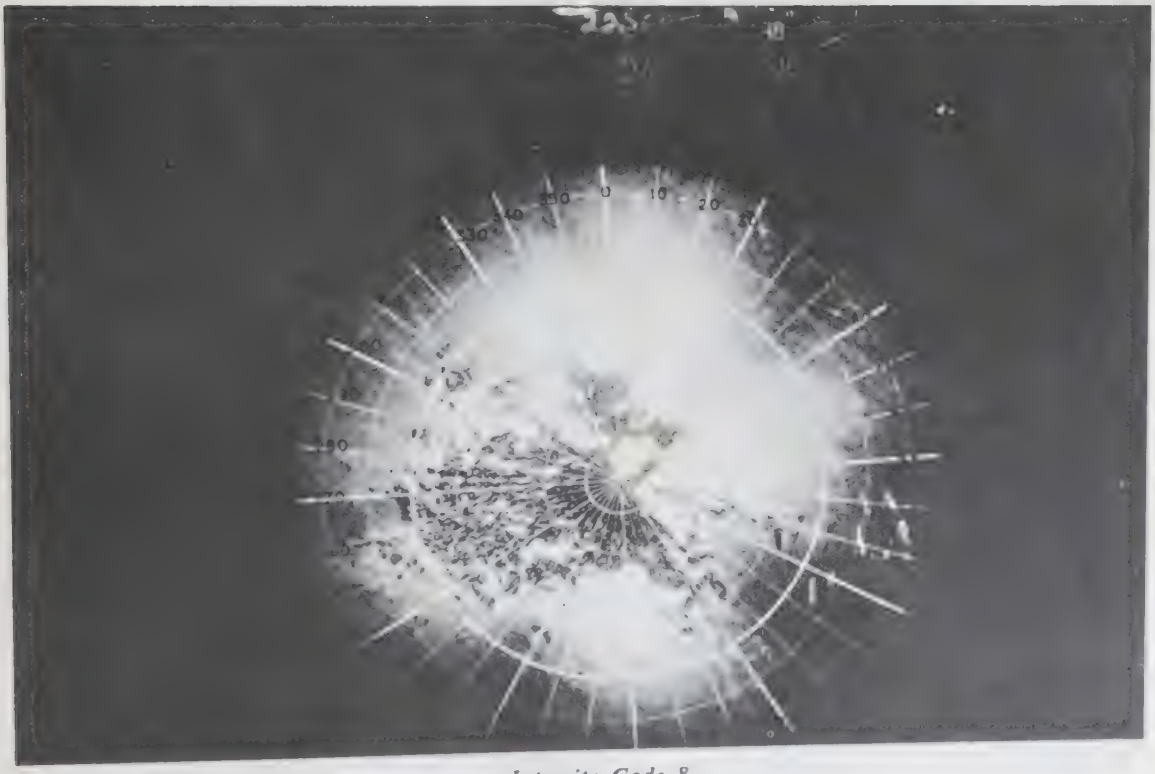


Intensity Code 8.

Temperature Recorder

Mr. Johnston places the recorder in its cannister.

A compact temperature-recording instrument which can operate unattended for periods of up to one year has been developed by the National Research Council.

NRC's Division of Building Research developed the instrument to facilitate the study of the average annual ground temperature and the range of temperature fluctuations in permafrost at various depths. This is an important part of permafrost research being conducted by the Division's Northern Research Group in remote areas.

Modified versions of the instrument also can be used to measure water temperatures at the bottom of lakes and temperatures in other environments including buildings, attics and crawl spaces.

Various types of manually operated reading instruments and continuously operating electronic recording equipment now are available for measuring ground temperatures.

For frequent observations, manual methods are time-consuming, costly and sometimes unreliable due to observer error, and difficult field conditions. Electronic equipment generally requires regular maintenance and servicing, a major drawback if it is to be used in a remote area. In addition, observers trained in the use and servicing of manually or electronically operated equipment are not usually available.

The new NRC instrument, designed by technicians Clement St. Jacques and Roger Tetu, meets a need for a simple temperature-measuring device of reasonable accuracy which will continuously measure and record ground temperatures for a one-year period. It requires no external power source, read-out apparatus or accessory equipment of any kind and no servicing while in operation.

The seven-pound instrument consists of two major components — a temperature-sensitive bimetallic strip and a battery-powered electric clock. Two 1½-volt flashlight-size mercury batteries connected in series are used as the power supply. The coil-wound bimetallic strip contracts or expands in response to temperature fluctuations and moves a pointer attached to one end.

The pointer leaves a trace on a pressure-sensitive wax-coated paper disc fixed to a metal disc, 3¼ inches in diameter, which makes one complete revolution in one year. The disc is rotated through an arrangement of gears by the battery-operated electric clock motor. The complete assembly is placed in a moisture-proof metal canister 3¾ inches in diameter and 11 inches long for installation in the ground.

By changing the gearing arrangement the recording time can be lengthened or shortened. The recording range of temperature can also be increased or decreased by changing the size of the wax-coated paper disc.

The instrument is capable of measuring temperature fluctuations within a range of 20 degrees Fahrenheit. Temperatures in permafrost at depths of from three to 30 feet may lie between 20 and 40 degrees F.

After fabrication each instrument is adjusted and calibrated for the temperature

Mr. Johnston lowers the recorder in a test hole.

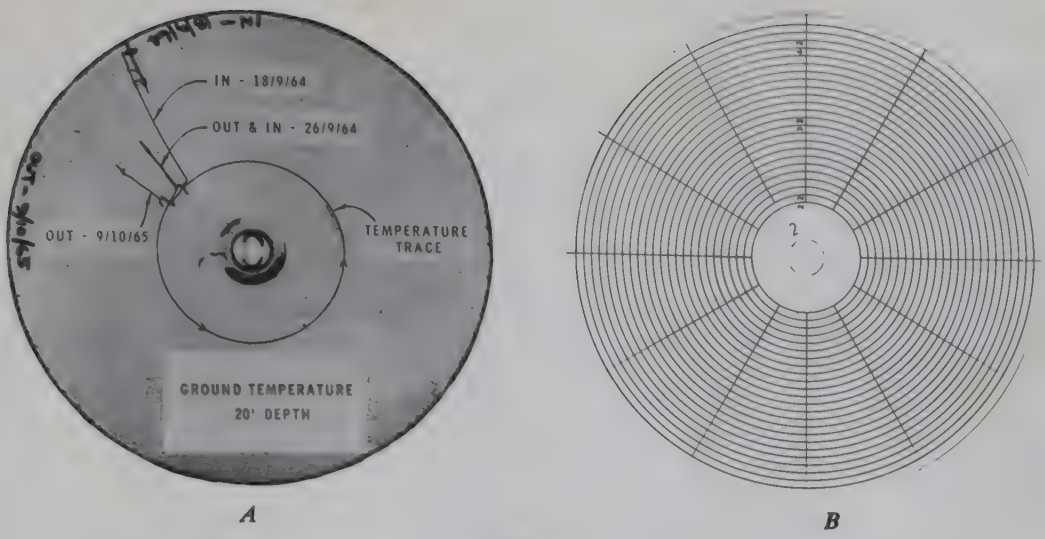


Figure 1
A—One-year ground temperature record. B—Temperature template.

range to which it will be exposed at a particular location. A special transparent template made of lucite, on which one degree temperature intervals are inscribed, is also made up following calibration.

Following completion of a test, the template is placed over the wax-coated paper disc to obtain the temperature fluctuations as shown by the trace left by the pointer. A typical chart and template are shown in figure 1.

Laboratory tests and field checks indicate that the accuracy obtained with the instrument is better than one degree F., probably about plus or minus 0.5 degree F.

Lake bottom water temperatures also have been measured using a slightly modified version of the instrument. All components of the water temperature device are virtually identical with the exception that a wax-coated disc five inches in diameter is used to increase the range of temperature measurement to 40 degrees F. The protective canister is correspondingly larger, measuring six inches in diameter and one foot in length.

The canister, weighted if necessary and mounted on three legs, is lowered to the bottom of the lake by a stainless steel cable. A set of brightly painted copper floats is attached to the top end of the cable and placed beneath the ice cover. The floats, along with off-shore reference points, serve to mark the location of the instrument.

G. H. Johnston, a research officer with the Northern Research Group, says the instrument is particularly useful whenever long-term temperature records are required at locations that are remote or where access is difficult or impossible in winter.

Technician Lynn Boyd prepares to lower water temperature recorder through hole in ice.

Centrifugal Impeller Study

Mr. Fowler demonstrates how he examines trails of smoke injected into one of the channels of a model compressor impeller.

A National Research Council engineer sits and spins in an unusual experiment designed to obtain information which will make jet aircraft engines more efficient.

The engineer — Howard S. Fowler of the Engine Laboratory of the Division of Mechanical Engineering — is attempting to improve the design of centrifugal impellers, such as those used in many gas turbines. Information obtained in the research project may also be of value in the design of centrifugal compressor impellers used for mine shaft ventilators, car water pumps, vacuum cleaners, hydraulic machinery and compressors used in the liquid gas industry.

In an aircraft jet engine of the centrifugal type, the compressor impeller draws in air, compresses it by centrifugal force and forces the compressed air into the engine's combustion chamber. The air is then heated by burning fuel in it, and escapes through the engine's jetpipe at tremendous speed, providing the thrust that drives the aircraft forward.

Mr. Fowler has developed an unorthodox method for identifying the complex secondary flow patterns within the centrifugal impeller. Instead of mounting tiny remote controlled instruments within the passages of an impeller operating at high speed, he has built a model of a compressor impeller which is ten times the size of an actual machine. He then rotates with the model impeller, strapped into a seat which is fixed inside the hub of the impeller. This is the only known example of this technique being used for compressor research.

The model impeller rotates at up to 70 revolutions per minute. Mr. Fowler plots the flow streamlines by observing the course of trails of smoke injected into one of the channels of the impeller, which is fitted with a window to allow him to see the smoke. He measures the flow speeds along these streamlines with a hot-wire anemometer.

He aims to test the basic assumptions of a theoretical flow analysis, worked out from first principles, so as to provide a surer method for engineers at the design stage.

The present model compressor is the second to be built in the Engine Laboratory, and incorporates in its design the lessons learned in two years' work on the first test rig. At first, the observer experienced loss of orientation and dizziness after a few minutes of rotation, but this drawback was overcome by using a technique suggested by Dr. G. Melvill-Jones of the McGill Uni-

versity School of Aviation Medicine. To keep the head perfectly steady, the observer clasps a fixed, specially shaped clamp with his teeth. Tests of up to half an hour at 50 to 70 revolutions per minute are now being carried out as standard procedure, without any signs of dizziness.

In this three-year study of the air flow patterns in the centrifugal impeller, it has been possible to obtain more detailed information on the flow field actually existing in a rotating impeller than has previously been available from more orthodox experiments.

Engineers in the U.S.A., Europe and Japan have been following these studies with interest.

The work has shown that there is an optimum running clearance between the vanes of the impeller and the casing in which it runs. This is approximately the value used at present in jet engine manufacture. Contrary to what has been thought, however, the reduction of this clearance, through more sophisticated manufacturing methods, could even reduce the compressor efficiency a little, rather than improving it.

In the same connection, the smoke trails have shown that a rotating shroud or cover-plate on the impeller leads to bad flow distribution, despite widely-held views to the contrary.

From tests on a complete impeller model Mr. Fowler was able to obtain a good picture of the flow in each channel of the impeller under study.

To gain an even fuller understanding of the flow patterns, he is now examining the air flow in a single, simplified channel. A special impeller model has been built for this purpose, to fit into the compressor system. It has only one channel constructed of transparent plastic, with the simplest possible geometry of straight sides rather than the curved vanes found on the conventional impeller. The remaining twenty or so channels are completely omitted from this model.

While studying the boundary layer flow (the flow in that layer of air which lies closest to the surface of the impeller vanes), Mr. Fowler will add the various geometrical complications, one after another until he has a complete model of the practical impeller passage. This should lead to a better understanding of the fully developed flow patterns already observed, and enable manufacturers to modify their designs, if necessary, to permit best possible air flow.

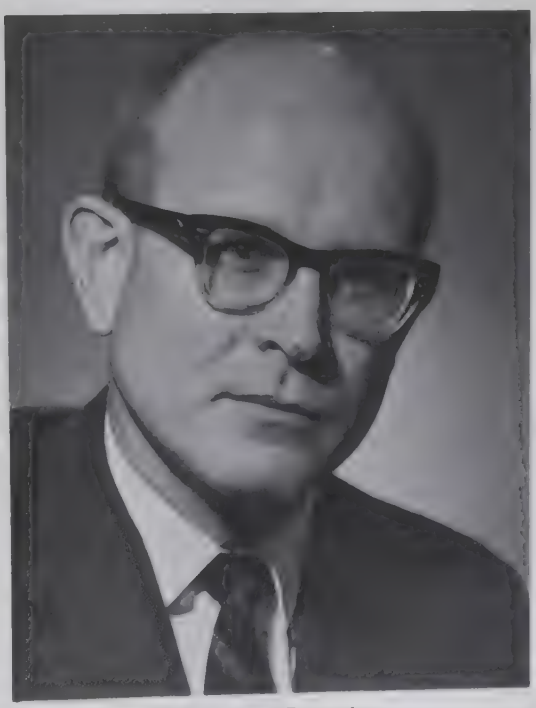
Assistant Director

William A. Cumming, 40, an electrical engineer, has been appointed Assistant Director of the Radio and Electrical Engineering Division of the National Research Council, effective January 1, 1967.

Mr. Cumming received his early education in Sault Ste Marie, Ontario, and district schools. He joined the staff of NRC in 1947 after graduating from Queen's University, Kingston, Ontario, with a B.Sc. degree in Engineering Physics. His initial work with the Radio and Electrical Engineering Division was in the field of electromagnetic waves, with particular reference to antennas and microwave devices.

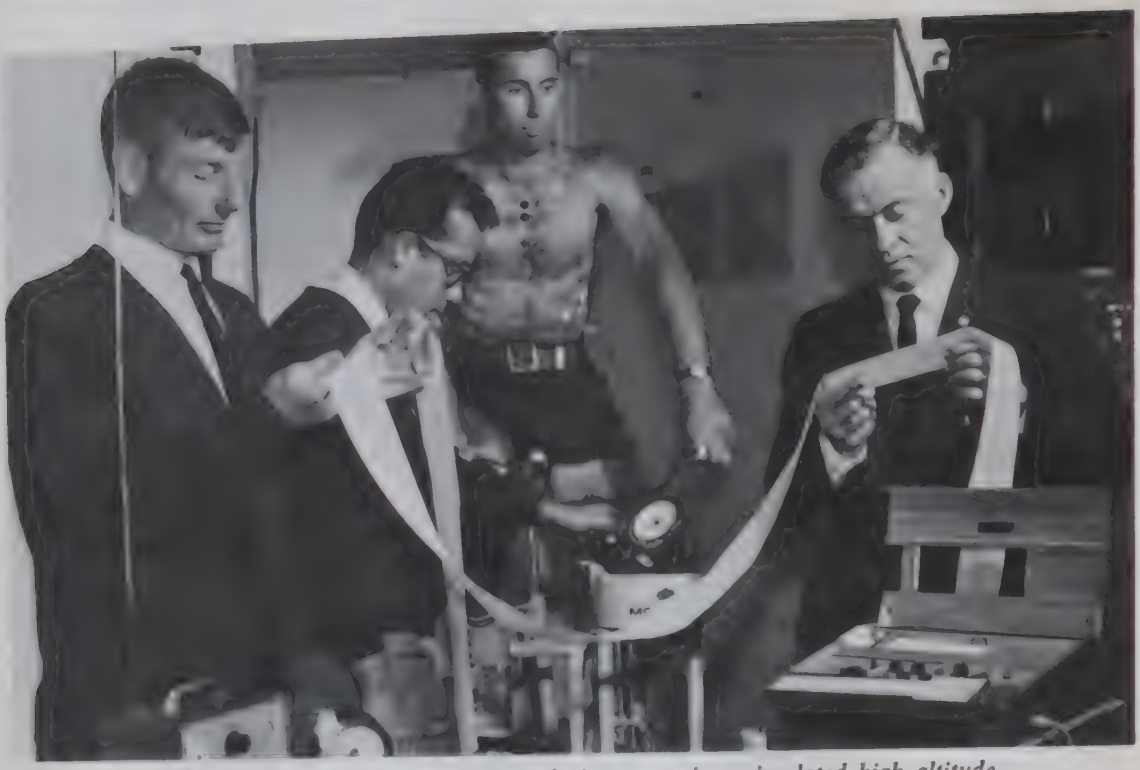
Subsequent to acting as project engineer on NRC's new 150-foot radio telescope at the Algonquin Radio Observatory in Ontario's Algonquin Park, he was named head of REED's Antenna Engineering Section, a post which he retains.

Mr. Cumming is a senior member of the Institute of Electrical and Electronic Engineers, and a member of the Association of Professional Engineers of the Province of Ontario.



William A. Cumming.

Respirometer at UBC



The physical responses of an athlete during a test in a simulated high altitude environment are recorded on tape. Dr Banister (left) and Dr. Nordan (right) examine tapes after a test inside the respirometer.

A physical educator at the University of British Columbia is using a unique machine to prove that athletes can be acclimatized to high altitude conditions without leaving sea level.

Dr. Eric W. Banister, Assistant Professor of Physical Education at UBC, has been using a respirometer, the only one of its kind in Canada, to simulate high altitude conditions by altering the oxygen level inside the machine.

Preliminary tests, carried out on himself and seven members of UBC's grass hockey team, show that athletes can be pre-trained at sea level in preparation for performing at high altitudes.

"One of the unanswered questions about acclimatization is just how long an athlete needs to adjust to an alien environment," Dr. Banister says.

To try to answer this and related questions Dr. Banister selected a group of students and measured their physical performance both inside and outside the respirometer, a chamber measuring four feet by eight feet by eight feet.

The respirometer was constructed by Dr. Harold Nordan, Assistant Professor of Zoology at UBC, with a $12,500 grant he and his co-workers in zoology received from the National Research Council. The bulk of the experimental work done with the machine is in the field of animal physiology by UBC zoologists. The machine currently is being used by a vertebrate zoologist to assess metabolic activities under various nutritional and environmental circumstances. The investigations involve various species of deer, beaver, opossum and seals.

Inside the machine the students pedalled a stationary bicycle once a week for eight weeks. Altitudes of 8,000 and 12,000 feet were simulated by reducing the oxygen content of the closed chamber.

The end result of the tests and measurements carried out by Dr. Banister was a measureable improvement of performance by the students at both sea level and high altitude.

"The results obtained so far indicate a trend but are by no means conclusive" Dr. Banister said. During the coming year he will expand the research program by applying more sophisticated tests designed to measure a wider range of altitude reactions.

His research will be supported by a $13,930 grant from the Canadian govern-

ment's Department of National Health and Welfare.

As a result of his experiments, Dr. Banister has a theory that the next big step forward in breaking athletic records may be the result of training carried out in an alien environment.

"At present," he said, "athletes such as sprinters and distance runners are reaching a point where they can't reduce their times any further by training under normal conditions at sea level."

He said the experiments which he has carried out suggest that improvement in training methods would result if athletes trained first in a simulated high altitude environment before attempting to set records at sea level.

He said his theory would apply only to athletes for whom the endurance factor was important. "I don't think it would be useful to weightlifters, for instance," he said, "since this type of athlete requires quick, explosive bursts of energy in competition."

Fellowship

Dr. Richard F. W. Bader, 35, Professor of Chemistry at McMaster University, Hamilton, Ontario, has been awarded the E. W. R. Steacie Memorial Fellowship for 1967 by the National Research Council.

Dr. Bader, one of the outstanding theoretical chemists in Canada, is the third recipient of the Fellowship which was established by NRC in March, 1963, to perpetuate the name of the late Dr. E. W. R. Steacie, President of the Council from 1952 to 1962.

Reflecting Dr. Steacie's outlook and principles, the award is designed to give outstanding and promising young staff members of Canadian universities an opportunity to spend two or three years in uninterrupted research. It normally is held for two years but may be renewed for an additional year.

Dr. Bader plans to use the period in which he will hold the Fellowship to approach problems in the field of theoretical chemistry from an increasingly fundamental point of view.

Born on October 15, 1931, at Kitchener, Ontario, Dr. Bader graduated from McMaster University in 1953 with a B.Sc. in Honours Chemistry. He received his M.Sc. in Chemistry from McMaster in 1955 and his Ph.D. in Chemistry from the Massachusetts Institute of Technology in 1958.

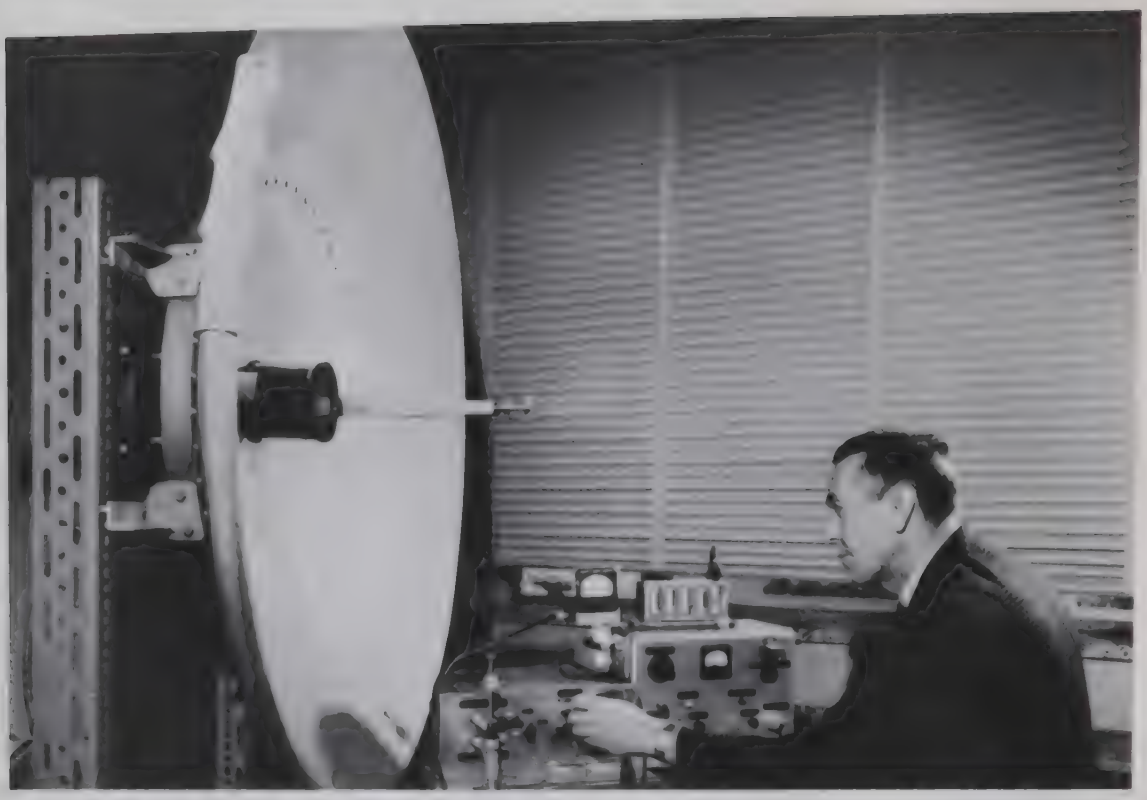
Dr. Bader was appointed Assistant Professor of the Department of Chemistry of the University of Ottawa in 1959 after spending 1958-59 as a Postdoctorate Fellow at Cambridge University, England. He was appointed Associate Professor in 1962 and in 1963 was named Associate Professor of the Department of Chemistry at McMaster University. In 1966 he was appointed Professor of the department.

The Steacie Memorial Fellowship is limited to research in the natural sciences. It must be held in a Canadian university or affiliated research institute and will normally be held by a university staff member at his own university. There is no restriction as to nationality or citizenship of recipients.

Dr. Bader's use of the Hellmann-Feynman Theorem to calculate atomic forces and from them electron density distributions in hydride molecules has provided an important advance in the understanding of chemical bonding. He also has used this approach to advantage in calculating electron densities in the transition states of hydrogen transfer reactions and has contributed materially to the current question of the relative importance of stretching and bending force constant changes in determining the magnitude of kinetic hydrogen isotope effects in these reactions.

Dr. Richard F. W. Bader.

Radar Altimeter



Mr. Westby examines prototype of the new radar altimeter. The antenna dish and aerial camera (left); the indicator circuit, receiver and meter (right).

A new radar altimeter developed by the National Research Council will overcome a major difficulty in the use of large-scale aerial photography to obtain a continuous inventory of Canada's forests.

The instrument was designed by the Council at the request of the Federal Department of Forestry and Rural Development which for some years has been attempting to develop a technique to determine forest inventories from large-scale aerial photographs. One of the most important facts that must be known to permit information about a forest area to be extracted from aerial photographs is the height of the survey aircraft. The height must be recorded on the photographs as they are taken at a rate of up to eight frames a second.

Radar altimeters determine height by measuring the time it takes for radar pulses to travel from the altimeter's transmitter to the ground and back.

Experiments by the Department of Forestry have shown that available radar altimeters are not accurate enough for this type of aerial photography. Not enough of the energy of their signals is able to penetrate the forest foliage and strike the ground at flying heights of 1,000 to 2,000 feet. As a result it cannot be determined whether their signals are returned from the ground, from the tops of trees or from some point in between.

The Department of Forestry asked NRC in the spring of 1965 to develop an inexpensive radar altimeter capable of transmitting a signal that would not be seriously affected by forest foliage. The job was given to R. L. Westby of NRC's Radio and Electrical Engineering Division, who was assisted in the work by Frank Alie.

Mr. Westby says that work completed by the Department of Forestry prior to the spring of 1965 proved the feasibility of obtaining forest inventories from the air by photogrammetry. However, this would be possible only if the height of an aircraft flying at 1,000 to 2,000 feet could be measured and recorded on each photograph with an accuracy of plus or minus one per cent.

A conventional radar with a narrow beam could be built that would transmit a signal that would not be affected by forest cover. However, it would require a very large

antenna, which could not be installed in the small aircraft used for aerial photography.

Mr. Westby has developed a prototype radar altimeter with a narrow beam which requires an antenna dish of only 44 inches, making it suitable for installation in small aircraft. More energy is reflected from the ground than from the tops of trees as a result of the frequency used.

"The reason that we can record that part of the signal that struck the ground and not the trees is that we look at the peak of the energy being returned," Mr. Westby says. "The peak of this energy is the signal from the ground."

The complex circuitry which makes possible this method of reading to the peak of each separate pulse has been patented by Canadian Patents and Development Limited, a subsidiary of NRC. It is the key to the success of the new altimeter.

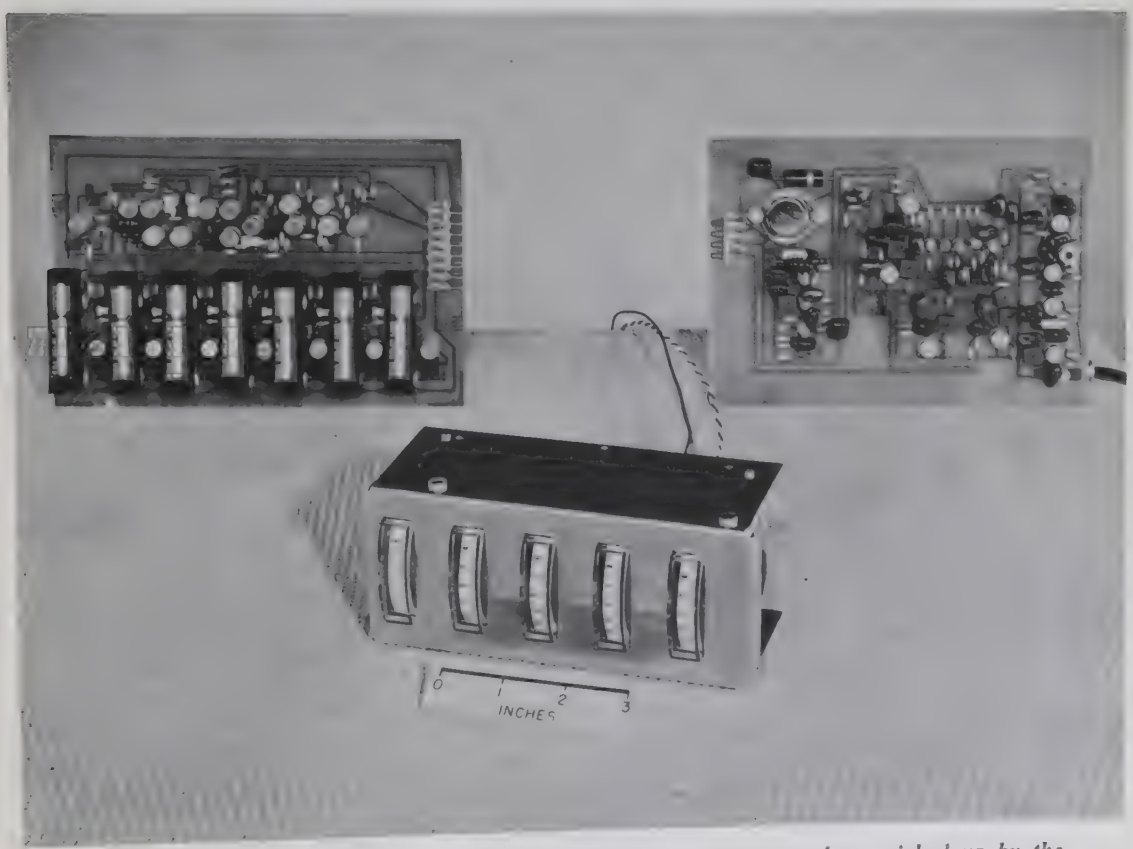
The aerial camera is located inside the antenna dish which is mounted on the underside of the aircraft. Each radar pulse returned from the ground is converted into an electrical voltage which is proportional to the time it took for the pulse to travel to the ground and back.

The voltage of each pulse is fed into a meter which reads off height in feet, and which is located alongside the camera. A special lens system makes it possible for the camera to photograph the meter reading each time a photograph is taken.

Mr. Westby says the maximum error of the height recorded on each photograph is plus or minus five feet. This compares with an error of up to 75 feet with the use of present altimeters.

To achieve this accuracy, the altimeter measures the time it takes for a radar pulse to travel to the ground and back to within 10 nanoseconds or 10-billionths of a second. At 1,000 feet a radar pulse takes 2 microseconds or two-millionths of a second to travel to the ground and back.

Mr. Westby says experiments with the new altimeter installed in a small fixed-wing aircraft and in a helicopter show that the instrument will be very useful for large-scale aerial mapping. Development work of the prototype altimeter is expected to be undertaken by industry.



The altimeter's receiving equipment. Radar pulses from the ground are picked up by the receiver (right). They are fed into the indicator circuit (left) where they are converted into an electrical voltage. The voltage of each pulse then is fed into the height meter (centre).

Copper Smelting

Mr. Dudgeon (left) and Vince Evans with the analyser control cabinet. The temperature of molten metal is measured before a test is made to determine copper end point.

Primarily because of the smaller volume of production, metallurgical techniques in the smelting and refining of copper ore have not undergone the rapid changes that have occurred in recent years in iron and steel production. Many stages in the copper production process still rely on human judgment and new types of instrumentation are required to give improved control of the process. A co-operative study by the Mechanical Engineering Division of the National Research Council and Gaspé Copper Mines Ltd., of Murdochville, Quebec, is aimed at developing new instrumentation for use in the smelting process.

The first stage of copper smelting and refining is known as a reverberatory furnace. The ore concentrate is melted and impurities such as iron and silicon oxides are skimmed off, leaving a "matte" containing about 40 per cent copper.

In the second, "converter" stage the iron and sulphur impurities are removed by oxidation and slagging. The product of the converter is called "blister copper" and is about 98.5 per cent copper.

An anode furnace and electrolytic refining are used in the third and fourth stages to finally reduce the impurities in the copper to less than 0.01 per cent.

E. H. Dudgeon, an engineer with the Mechanical Engineering Division, says the experiments were conducted to learn whether a crucial stage in the converter process could be determined automatically. At present the determination of when this stage is reached depends on the skill and experience of the converter operator.

This crucial stage in the converter process is known as the "copper end point," and is one of the most critical measurements in copper smelting.

The converter stage must be carried far enough to remove, through oxidation, the highest possible amount of impurities. However, if the process is carried too far (goes beyond the copper end point) the copper itself starts to oxidize. This situation then must be corrected in the (third stage) anode furnace by the injection of a reducing gas or other means to de-oxidize any copper oxide.

The skilled converter operator relies on four signs to indicate the copper end point:

1. Dust from the converter's exhaust flue turns from black to red as copper sulphide is replaced by copper.

2. A steel bar inserted quickly into the molten metal through an air injection port collects a thin skin of solidified copper. The manner in which the skin contracts and wrinkles as it freezes will indicate to an experienced operator the approach of the end point.

3. The gas discharge from the converter undergoes a rapid change in appearance, rather like a flame dying, as the end point is reached.

4. A sample of molten metal removed from the converter by a long-handled spoon congeals in a characteristic manner as the end point approaches. The converter must be stopped each time a sample is taken and a number of samples may be necessary before the end point is reached.

Even small errors in determining the end point in the converter process can cause undesirable extensions to the later stages of purification. A measuring system that could indicate reliably, independently of the operator's discretion, when the end point is reached could yield considerable savings in total processing time. Not only would the time required in the anode furnace be reduced to a minimum but the converter period itself would be shortened.

Recent experiments in the laboratory at the National Research Council, and in the smelter at Gaspé Copper Mines, indicated that the sulphur dioxide content of the flue gas of the converter might be a suitable indicator of "copper end point."

The experiments indicate that there is a rapid drop in the sulphur dioxide released in the converter stage as the copper end point is reached. It may be possible, therefore, to use the slope of the sulphur dioxide curve, as measured by a fast infrared analyser, to determine copper end point accurately, without reference to melt samples and less dependent on operator skill and experience. This could be a step toward automatic control of the entire copper converting process.

"The results of the experiments indicate that the rapid measurement of the sulphur dioxide level in the gas released from the converter has potential as a new and independent method of determining the end point in converter operation," Mr. Dudgeon says. "With over-all response times of the order of 10 seconds, this method can generally indicate the end point with as good an accuracy as is presently achieved by an experienced operator observing flame characteristics or taking melt samples."

The analyser system used in the tests at Gaspé Copper Mines Limited was constructed as an experimental unit. Minor improvements would be required to provide an industrially reliable unit.

Steacie Prize

Dr. Gordon H. Dixon, 36, of the Department of Biochemistry of the University of British Columbia, has been named the 1966 winner of the Steacie Prize.

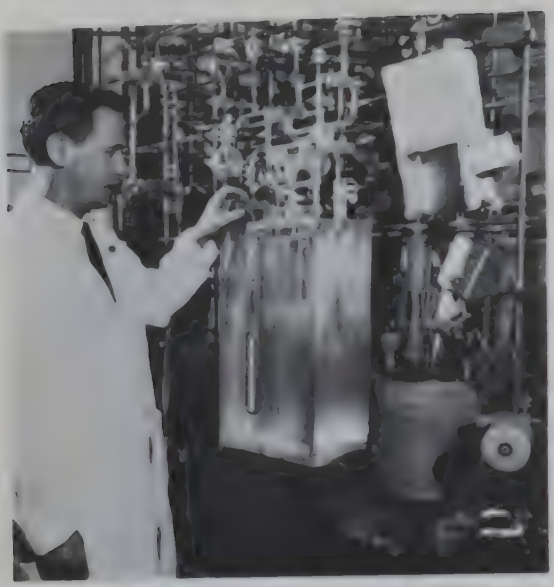
The prize consists of the income from the E.W. R. Steacie Memorial Fund to which colleagues and friends of the late President of the National Research Council contributed. It it awarded annually by the Trustees of the Fund for outstanding work done in the natural sciences by younger people.

Dr. Dixon received the Prize, which consists of a cash award of $1,200, for his important work on the synthesis of insulin and on the structure of haptoglobins.

Born in Durban, South Africa, Dr. Dixon is a graduate of Cambridge University (B.A. 1951) and the University of Toronto (Ph.D. 1956). Before being appointed to his present position at the University of British Columbia in 1963, he was on the staff of the Connaught Medical Research Laboratories and the Department of Biochemistry of the University of Toronto.

Dr. Gordon H. Dixon.

Autoxidation



Dr. Ingold examines the equipment he uses in his autoxidation experiments.

The importance of the chemical process known as autoxidation as a cheap synthetic route to the production of commercially valuable chemical products should increase rapidly during the next few years.

Autoxidation, the oxidation of a substance by gaseous oxygen, is used to produce such diverse compounds as ethyl alcohol, acetic acid and some intermediates for the manufacture of nylon and dacron. Many other valuable chemical products can be produced through the partial oxidation of hydrocarbons derived from petroleum.

In an effort to learn more about this process, a research program covering several aspects of autoxidation was initiated some years ago by the Division of Applied Chemistry of the National Research Council.

The research is being conducted by the Division's Hydrocarbon Section under Dr. K. U. Ingold, Section Head. Others engaged in the work with Dr. Ingold are Dr. J. A. Howard, Dr. E. C. Horswill and four Post-doctorate Fellows, Dr. I. T. Brownlie, Dr. D. J. Carlsson, Dr. B. R. Kennedy and Dr. H. S. Middleton.

The reaction of organic compounds with oxygen from the air is one of the most important of all chemical processes. The most familiar examples are the relatively slow oxidation of the blood in breathing, and the very much faster oxidizing process that takes place when things burn.

But in a host of less spectacular chemical reactions, the original organic material is not degraded or reduced all the way down to final products of carbon dioxide and water. Many of these gentler processes occur more or less spontaneously under comparatively mild conditions and so they are known as autoxidations.

The first stable products produced by autoxidation generally are hydroperoxides. They may be useful themselves or as intermediates for the production of other chemicals. For example, cumene hydroperoxide which is produced by the autoxidation of cumene, can be catalytically decomposed by acids to yield phenol — used as a disinfectant and in the manufacture of plastics or dyes — and acetone — a solvent. Hydroperoxides also may be further oxidized to produce alcohols, acids and ketones.

These autoxidation processes can be accelerated by adding certain metal catalysts and can be encouraged to proceed in particular directions with other additives. For instance alcohol production is enhanced by the addition of boric acid.

Dr. Ingold and his group are now engaged in a study of the relative rates of consumption of different hydrocarbons in oxidizing mixtures. He says in the next few years this research should make it possible to make useful quantitative predictions about many important features of the oxidation of complex hydrocarbon mixtures.

"As a consequence, the importance of autoxidation as a cheap synthetic route to commercially valuable products should increase rapidly," says Dr. Ingold.

Autoxidation is the cheapest and simplest method of oxidation because air is used as the oxidizing agent. Many chemicals are produced by oxidation but their manufacture frequently requires the use of more expensive oxidizing agents such as hydrogen peroxide or nitric acid.

The autoxidation process can also produce harmful effects. Edible fats and oils go rancid, sludge forms in lubricating oils and rubber and plastics deteriorate slowly.

These harmful effects can be reduced by adding small amounts of certain compounds known as inhibitors. At low temperatures, the inhibitors used are generally phenols or amines. At high temperatures, certain sulphur-containing compounds are more efficient as inhibitors.

When the two types of inhibitors are used together, their combined effect is often greater than the sum of their individual effects, a phenomenon known as synergism.

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COVER

BLACK AND WHITE REPRODUCTION OF PAINTING "SERIAL STRUCTURES"

By Anne-lore Daniels

For several years I have been concerned with the affinity between the visual and the acoustic in art: I have attempted many times to paint music. When certain colors and forms are juxtaposed the components of a picture seem to dance, even though the movement is in the eye of the beholder.

My painting was done to complement the serial sound structure generator developed by Dr. Hugh LeCaine in the Radio & E. E. Division's electronic music laboratory; and the two were displayed together in the Man and Music Pavillion at Expo 67. Starting with forms derived from the symbols of music and electronics I have taken a series of colors, and a series of shades of grey to represent two aspects of pitch in music, and a series of lengths to suggest durations.

Detect Gas Leakages

Mr. Russell and Mr. Bednas test drill core sample for natural gas.

A gas chromatographic method has been developed by the Division of Applied Chemistry of the National Research Council of Canada to detect natural gas leakages in soil.

Current methods for detecting natural gas leakages cannot be used to determine whether natural gas is present in soil. Odorants usually added to natural gas for detection purposes are retained by soil. This means that natural gas leakage has sometimes escaped detection because the soil has absorbed the detecting odor.

The Analytical Section of the Division of Applied Chemistry recently undertook a research project to find a method by which natural gas leakages in soil could be pinpointed and also distinguished from propane gas, sewer gas, organic decomposition and gasoline spillage. The method at the moment requires that drill core samples be analysed in the laboratory.

M. E. Bednas and D. S. Russell of the Analytical Section say the work was undertaken because leaks in underground natural gas distribution systems have frequently been the cause of serious fires and explosions. Gas from a leaking pipeline has been known to travel through porous soil and loose backfill for many feet before entering basements through cracks or service holes in the walls. This is a particularly serious problem during the winter when the frozen earth seals off the surface and traps the gas below.

The new gas chromatographic or chemical analysis method is able to detect natural gas in soil and distinguish it from other gases because odorants often used in natural gas distribution systems contain minor amounts of hydrocarbons. These impurities in odorants can be detected by the new method in drill core samples.

The minor hydrocarbon impurities in odorants, derived from petroleum, are convenient tracers for determining natural gas in soil and distinguishing it from other gases, Mr. Bednas and Mr. Russell report.

These hydrocarbons give a characteristic chromatogram for natural gas which is not likely to be duplicated by gases from other sources. This characteristic chromatogram will depend upon the minor components in the particular odorant employed. In the case of bottled propane and spilled gasoline, natural gas may be readily distinguished by its main component, methane.

Eskimo Study

Mosesie, an Eskimo at Igloolik, runs full out in shallow water shortly before spearing an Arctic char, a staple food to him but a dream fish to the gourmet.

A new working arrangement has been reached by Canadian, American, Danish and French scientists to make possible an international study of the adaptability of Eskimos before their culture is submerged by the white man.

The arrangement represents an expansion of an earlier accord between Canadian and American scientists for a study of Eskimos in the Canadian and American Arctic.

Under the new arrangement, Canadian scientists plan to examine Eskimos at Igloolik, a remote settlement off the northeast coast of Melville Peninsula in the Northwest Territories. American scientists will study Eskimos at Wainwright, Alaska; and Danish and French scientists will study groups of Eskimos in Greenland.

The multi-nation study will be conducted within the framework of the International Biological Program, a 50-nation research program designed to give mankind new insight into the problems of survival in a world undergoing rapid technological changes. Studies under IBP of human populations will compare groups of peoples living by traditional means in various parts of the world in order to learn how they have adapted genetically, physiologically and technologically to their environments.

The Canadian Eskimo study, to be conducted in co-operation with the Eskimos concerned, is being co-ordinated by a Subcommittee on Human Adaptability of the Canadian Committee on IBP.

Dr. J. Sanford Hart, Chairman of the Subcommittee and Head of the Animal Physiology Section of the Division of Biosciences of the National Research Council of Canada, says Eskimos, like other groups of peoples, are becoming increasingly changed by contact with European stock. He says it is hoped that these changes in Eskimos "can be recorded before their culture disappears forever."

Eskimos are considered uniform racially but exist in groups from Alaska to Greenland in increasing genetic isolation from their original point of origin—Alaska.

Under the arrangement, the multi-national teams will attempt to determine whether there are any regional population trends correlated with the presumed genetic differences. This requires correlation of genetic markers with other studies in a multi-disciplinary approach.

If the Eskimos across the Arctic turn out to be genetically similar, any regional differences will be attributable to environmental factors, the nature of which should be revealed by the study. Probable regional differences requiring special attention include differences in social customs, in physical environment, in nutrition and availability of food, in disease patterns and in degree of contact with Europeans in the past and at present.

Probably the most powerful influence operating on the Eskimo today is the change in his traditional culture due to pressure from the white society.

A basic question to be asked by the Canadians and the other groups is what is the effect of this acculturation on the Eskimos. In the Canadian study at Igloolik, scientists from the Universities of British Columbia, Manitoba and Toronto; McGill University, Montreal; Memorial University, St. John's, Newfoundland, and the Federal Health Department, plan to study Eskimos of common genetic background living with various degrees of contact with the white man.

"It is hoped by an internal comparison of the population to sort out the effects of this contact by study of social and disease patterns, nutrition, activity, physiology and ecology within the population," Dr. Hart says.

Steacie Fellowship

Dr. William R. Datars, 35, Associate Professor of the Department of Physics at McMaster University, Hamilton, Ontario, has been awarded the E. W. R. Steacie Memorial Fellowship for 1968 by the National Research Council of Canada.

Dr. Datars, a solid state physicist, is the fourth recipient of the Fellowship which was established by NRC in March, 1963, to perpetuate the name of the late Dr. E. W. R. Steacie, President of the Council from 1952 to 1962.

The Fellowship is designed to give outstanding and promising young staff members of Canadian universities an opportunity to spend two or three years in uninterrupted research. It normally is held for two years but may be renewed for an additional year.

Dr. Datars plans to use the period in which he will hold the Fellowship to continue his scientific work at McMaster.

Born in Desboro, Ont., Dr. Datars graduated from McMaster University in 1955 with a B.Sc. in Physics. He received his M.Sc. in Physics from McMaster in 1956 and his Ph.D. in Physics from the University of Wisconsin in 1959.

From 1959 to 1962 Dr. Datars was Scientific Officer of the Electronics Laboratory of the Defence Research Telecommunications Establishment in Ottawa. He left that organization to join the staff of McMaster University as an Assistant Professor, remaining in that position until 1965, when he was appointed Associate Professor.

The Steacie Memorial Fellowship is limited to research in the natural sciences. It must be held in a Canadian university or affiliated research institute and will normally be held by a university staff member at his own university. There is no restriction as to nationality or citizenship of recipients. Recipients receive their normal university salary which is paid by NRC.

In the five years that Dr. Datars has been at McMaster, he has made a substantial impact upon the university in all its aspects—research, teaching and university activities. He is an active research worker and has built up a laboratory for the study of Fermi surfaces in metals and semi-metals fully equal to any in the world.

Microbial Cell Research

Photomicrograph (above) shows cells of the food yeast Candida utilis in phased culture at a stage about midway through the cell cycle. Dr. Dawson (below) in front of several cyclone column fermenters used for the continuous phased cultivation of Candida utilis.

Scientists at the Prairie Regional Laboratory of the National Research Council of Canada have made a "significant breakthrough" in methods for cultivating microorganisms.

Research in continuous fermentation at the PRL in Saskatoon has produced a novel method for exploring and exploiting microbial cells.

In normal cultures of microorganisms, the cells grow at random, and resemble the human population in which, every second that passes, individuals are being born, maturing, and reproducing. Microbiologists have long sought for methods of making colonies of small organisms grow all at the same time, in phase, so that nearly all of them go through their lives together. The new development, known as continuous phased growth, produces a continuous culture having most of the cells "in synchrony", that is, doing the same thing at the same time. The phased culture can be maintained over long periods at any chosen growth rate.

The NRC technique enables the gross performance of the population in a culture to be related to the individual behavior of the cell. This means, according to Dr. P. S. S. Dawson of PRL, that the detailed study of an organism and its growth metabolism can be made on the basis of the cell cycle at different growth rates.

In essence, this has the effect of studying a single microorganism throughout its life. But, since there are billions of them all at the same stage, each chemical product of a particular microorganism can be examined in quantity. Thus all products can be analysed in detail, repeatedly.

As a result of this, a clearer picture of cell growth and metabolism is emerging and a better understanding of the cell machinery becomes possible.

Over a century has passed since Pasteur first recognized the chemical activities of microbes which, in reproducing their kind, serve as highly efficient chemical machines and are potentially chemical factories capable of almost limitless synthesis.

Until 1950, all information regarding the chemical activities of microorganisms had been obtained from microbial cultures by the classical technique of batch culture. In this technique, growth takes place in a "closed system".

An organism requires a fixed amount of nutrient to duplicate itself. The speed at

which this is performed depends on the concentration of the nutrient available. Thus, in a closed system of a batch culture, an initial stockpile of rations becomes progressively depleted by the increasing population and, as the concentration of nutrient diminishes, the growth rate of the cells decreases. Throughout there is a sequence of change in the culture.

Close to two decades ago the theory of continuous culture emerged. It allowed scientists to study the culture at the level of the cell rather than the overall population so the activities of the individual microbial unit could be examined and appreciated.

In this culture, a continuous addition of fresh medium is made to a constant volume of growing culture and the flow concurrently displaces the growth increase produced as harvest. The simple "open system" arrangement is usually referred to as a chemostat.

This maintains a constant growth rate in the cells by virtue of the unchanging steady state established in the culture vessel by the flow through the system. The growth rate of the cells may be altered by changing the flow rate of the medium, so that the growth can be studied as a steady state at any desired growth rate.

However, in the chemostat, although all the cells are growing at the same rate, they are all at different stages of development in the reproductive cycle of a cell. Consequently the steady state which exists at a particular growth rate only reflects an average condition in the culture — that produced by the randomized contributions of the individual cells in the population.

The technique developed at Saskatoon, taking advantage of the experimental conveniences of the chemostat, permits the unscrambling of this randomized condition of the continuous culture and allows the cell cycle to be resolved at any particular growth rate. This is termed by Dr. Dawson as a "significant breakthrough" and was achieved by a relatively simple modification of the chemostat.

In the PRL method, instead of providing the medium as a steady supply of nutrient rations to randomly dividing cells in the population of a chemostat, a single addition is made to a population of synchronously dividing cells.

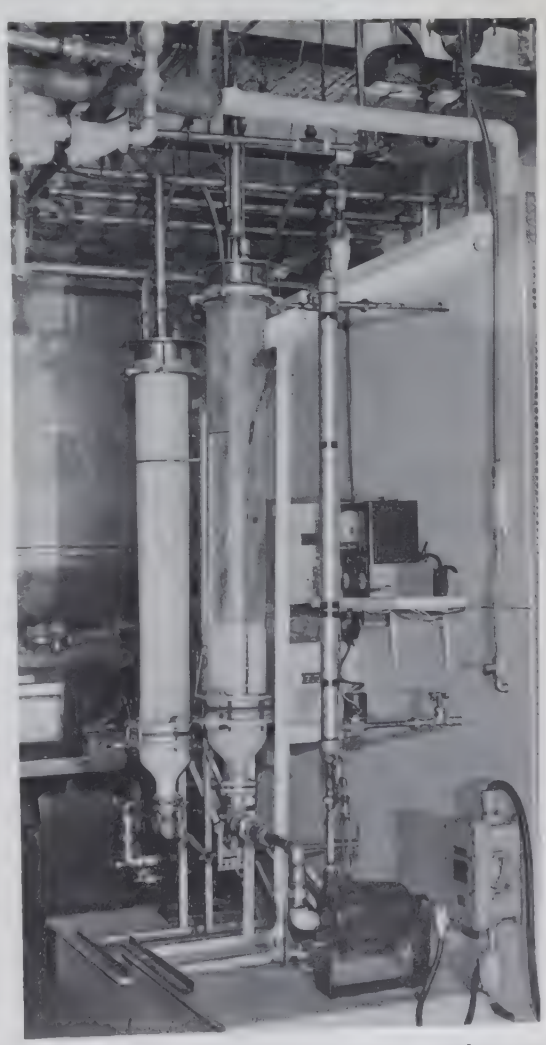
The cells grow along together and, at the end of the doubling period, receive another nutrient ration per cell. This process can be repeated indefinitely and thus a continuous synchrony is maintained.

By altering the periodicity of the dosage, the growth rate may be changed.

Dr. Dawson says that whereas continuous culture in the chemostat permits analysis of growth in equilibrium at different growth rates, the continuous culture of phased growth enables it to be related to the cell.

"The full significance of the subtle differences inherent in the continuous techniques becomes apparent when it is realized that, before their recent introduction, no method of culture existed for examining growth and metabolism with respect to the cell other than by observation under the microscope.

"Introduction of continuous methods for cultivating microorganisms opens a new era for microbiology," Dr. Dawson said. "Already, as the result of these innovations, modifications of previously held concepts of growth and metabolism are required, and some are revolutionary changes."



A two-stage pilot unit for continuous synchronous culture of microorganisms.

Air Cushion Vehicles

The SRN6 Hovercraft undergoes winter trials at Churchill, Man., in mid-February.

Private industry and government have joined forces in a preliminary effort to determine the role of the air cushion vehicle in Canadian transportation.

The National Research Council of Canada has authorized a market study and a preliminary design study of the applications of air cushion vehicles in Canada and also a report on various wider applications of the air cushion principle.

The study is expected to determine what types of air cushion vehicle are best suited for the various types of terrain to be found in Canada and to establish the economic feasibility of eventual manufacture of air cushion vehicles in Canada.

The study is to be undertaken by a consortium of six private companies and seven federal government departments and agencies representing operators, users, designers and producers of air cushion vehicles. Cost of the study has been set at $69,000, with $15,000 being absorbed by the six companies and the remainder by the government departments and agencies.

A. S. Jackson, projects officer of NRC's Division of Mechanical Engineering, has been named co-ordinator of the study.

Mr. Jackson said the first phase of the study calls for approaching a large number of Canadian transportation firms and users and determining if they have problems that can be solved through application of air cushion principles.

"We want to find what type of air cushion vehicle is best for travelling over muskeg, across snow, sand, over land and water. We want to know, for instance, if it is economically feasible to employ the air cushion vehicle concept for such roles in Canada as high speed ferries, pleasure craft, truck transportation, fire boats, airfield crash and rescue, survey work, agricultural use, and possibly other applications."

He said the study, if successful, would produce dramatic changes in transportation and cargo handling, particularly in the developing northern areas of Canada.

This is to be the first comprehensive look t the state of the art of the air cushion ehicle in relation to the needs of Canada, lthough a British-built Hovercraft is cur-ently being given low temperature tests at Churchill, Man., by the Department of Transport, and the Canadian Coastguard has purchased a second for search and rescue duties near Vancouver. Certain other aspects of air cushion techniques were investigated in a Defence Research Board program which terminated last year.

One of the companies involved in the study, Hoverwork Canada Limited of Ottawa, operated the British-built Hovercraft which carried 366,000 passengers at Expo '67 last year. It is also operator of the Hovercraft currently under test at Churchill and is consultant to the Coast Guard for setting up the Vancouver search and rescue Hovercraft unit. It is a wholly-owned Canadian company.

A. B. German, President of Hoverwork Canada Limited, says currently produced marine-amphibious vehicles are very expensive and concentrate on achieving high over-water speeds.

"It would thus appear at first glance that the application of air cushion vehicles in Canada is somewhat limited. However, the cost factor must be weighed against the very high costs of present methods of transportation in the developing areas of Canada. In addition, achieving a high rate of speed may not be particularly significant on the Canadian scene."

Mr. German also says that there are indications that more economical air cushion vehicles can be developed by using up-to-date techniques in light alloy fabrication and glass fibre fabrication which are available in Canadian industry.

Federal government departments taking part in the study include Agriculture, Industry, Transport, Energy, Mines and Resources and Indian Affairs and Northern Development. Agencies involved are NRC, and the Canadian Transport Commission.

"The air cushion vehicle is not the magic answer to everybody's transportation problems, but there are undoubtedly certain problems which can be solved far more economically by means of air cushion applications," Mr. German says.

Jean Bertin et Cie of Paris, France, and its associate company SEDAM are also involved in the study. SEDAM will be the company directly involved in the project.

SRN6 Hovercraft in the Lachine Rapids near Montreal.

The Bertin "Aerotrain" half-scale model achieved a speed of 212 miles per hour on test runs last December and the French government has authorized building of 20 kilometers of track for a full-scale Aerotrain between Paris and Orleans. Bertin has also done further work in the marine-amphibious field and is now constructing two prototypes of a 30-ton model to be used as a car-passenger ferry and military logistics machine.

A British Company, Hovermarine Limited of Southampton, Eng., has been engaged in design work in the marine sidewall craft which are highspeed ferry boats and ships. The first production model of their 60-passenger ferries go into commercial operation in England this summer. Hovermarine is also doing development and production work on small amphibious utility vehicles which could have a special application in Canadian lakes, rivers and swamp-muskeg areas.

Kenting Aviation Limited of Toronto is one of the leading Canadian firms in the field of aviation survey work and has a number of associated companies active in exploration, survey and drilling work in Canadian oil fields. One associate, Foremost Development Corporation, manufactures specialized tracked vehicles used in muskeg areas.

German and Milne, Naval Architects of Montreal have been actively associated with a number of projects involving the development of new devices and navigational techniques for winter marine operation. H. Heinrich, president of the Heinrich Aviation Consultants of Montreal, is a consultant to the group. His company specializes in investigations and planning in the transportation field.

Dr. C. R. Masson, Head of the Reactions at High Temperature Section of NRC's Atlantic Regional Laboratory, and Dr. S. G. Whiteway, received the first annual award for Best Paper Presentation at the 1966 Conference of Metallurgists held in Toronto. The award, announced late in 1967, was for a paper entitled "Diffusion of Oxygen in Liquid Silver by an Electrochemical Method".

New Mapping Technique

The National Research Council of Canada is working on further development of a new technique for the production of detailed maps from aerial photographs.

The earth's surface is represented in maps produced by this method by a precise photographic picture rather than by a set of symbols. Only the most important features are symbolized, because it can be assumed that the remaining contents of the map can be easily interpreted by the map user.

The new cartographic technique is being further developed by the Photogrammetric Research Section of NRC's Division of Applied Physics. In this work several pieces of new photogrammetric equipment, including a new type of orthophoto plotter, are being developed by the Section.

Theodore Blachut, Head of the Section, says the new technique should offer significant economic and technical advantages in the production of maps with attractive photographic qualities. These advantages include superior representation of terrain and faster and cheaper production through automation.

Mr. Blachut says the more detailed and more readable maps produced by the new technique could be a valuable asset in many fields, including the promotion of Canada's tourist industry. They could be used, for instance, for depicting and popularizing national and provincial parks and other areas frequented by tourists. Visitors could be supplied with interesting maps with easily discernible features of areas they plan to visit.

Aerial photographs of the terrain are always geometrically distorted because of the tilt of the aerial camera and the elevation differences of the terrain. As a result, the angles and distances measured on such a picture do not correspond precisely to the respective quantities on the ground.

To obtain a geometrically true image, the photographic picture must be transformed. Since this cannot be accomplished at once for the whole picture, the transformation must be done bit by bit in a special rectification process.

The orthophoto plotter automatically rectifies the distortions in the photographs. The resulting product is geometrically correct in every detail and elevations, distances and angles can be read off from the orthophoto map as from a conventional map. However, the orthophoto map contains a wealth of detailed information that cannot always be included on a conventional map.

This technique has been used by the Section in the production of an orthophoto map of the skiing area in Quebec's Gatineau district, some ten miles north of Ottawa. The map was skillfully printed by the Mapping and Charting Establishment of the Canadian Armed Forces.

This map embodies two new features. The hills are shaded to better express the topography of the area and to facilitate the reading of the map, and different colors were selected to portray the area in winter and summer. In the winter map, the landscape is blue and snow-covered lakes are white. For the summer map, the landscape is green and lakes blue.

"This feature alone could be very useful for depicting and popularizing our various national and provincial parks," Mr. Blachut says.

The Gatineau skiing area was selected for the experiment on grounds of scientific and practical considerations. The area presented a variety of problems that had to be overcome in the production of orthophoto maps. It also was within easy reach of the researchers involved in the experiment and provided a ready source of critics — the skiers.

Mr. Blachut says that since certain of the cartographic treatments were used for the first time, it is important to receive comments from map users. Consequently, a limited number of copies of the map have been distributed among persons willing to offer their opinions of the map after they have used it.

The Section was assisted in the production of the map by the Ottawa Ski Club, the Mapping and Charting Establishment of the Canadian Armed Forces and Spartan Air Services Limited, of Ottawa.

Model of CL-215 aircraft, developed by Canadair Limited of Montreal primarily for water bombing forest fires, undergoes tests in NRC wind tunnel.

Electronic Music

Dr. LeCaine at the controls of his Serial Sound Structure Generator.

A new electronic music machine developed by the National Research Council of Canada represents another Canadian advance in the field of electronic music.

Known as a Serial Sound Structure Generator, the machine is one of a family of devices which aid composers in the composition of music by electronic methods. It was developed by Dr. Hugh LeCaine of the Radio Astronomy Section of NRC's Radio and Electrical Engineering Division and the Electronic Music Studio of the University of Toronto.

The Generator is not a composing machine for programming extended musical compositions in real time. Rather, it is an elaborate device for examining and applying serial logic to various qualities of the electronic music texture. The output of the generator is electronic sound, which must be subjected to artistic choice and then cast in extended musical time employing the techniques of what has been called the classic studio. The primary function of the generator is to control the succession of sound events.

The inside of the Serial Sound Structure Generator is a mass of transistors; outside there are dozens of colored buttons which change octaves and pitch and a tiny light flashes for every "note" that sounds. Simply by switching dials, the composer can produce all possible combinations of the chosen qualities. He can listen to the still unwritten music score and test the electronic notes for duration, intensity, tone-color, attack, and decay.

A simplified version of the machine went on display to the public for the first time in the Man and Music Pavillion at Expo 67. Visitors got a chance to "compose" electronic music by pushing various buttons

controlling notes, timbre and pitch. Only one person could push the buttons at any one time, but earphones permitted as many as eight persons to listen in.

The generator now is at the University of Toronto, which began an extensive electronic music program in 1959. McGill University in Montreal started a similar program in 1964 and, more recently, another program was launched at Simon Fraser University, Burnaby, B.C.

Dr. LeCaine, one of North America's leading authorities on electronic music, says electronic music permits composers to experiment with any rythm, pitch or tone color they like, and to break out of the conventional system. It is not, however, an actual kind of music, but simply a technique for making music.

"We're all mentally lazy," Dr. LeCaine says. "The electronic system aids a composer much in the same way as a machine would aid an accountant. It gives him the mental energy to cover more ground and to see exactly what implications are contained in his original premise. What he composes is more truly his expression of his own subconscious idea about the piece—having seen more, he is able to pick the inspired combination better."

A musician thinks of flute tones and violin tones. But in electronic music he must think of the sound structure itself, for which he must invent not only words but a notation.

An electronic music studio has many kinds of recording equipment, and experiments are made with recorded sound. There are a few instruments like bongos and maracas, because they produce a special sound of their own, but otherwise all the equipment produces voltages which can be transmuted into sound.

Another of Dr. LeCaine's contributions to electronic music is a composition called Dripsody. A reviewer in High Fidelity Magazine describes the composition in these words:

"The whole composition is based upon the single sound produced by the fall of a drop of water. This is developed in all manner of ways—plain and fancy scales, played with a neat, pearly perfection any piano virtuoso might envy; bell tones of several kinds; long sustained pure tones; and mixtures of these several elements. The work is particularly useful as an introduction for the lay listener, who is always interested in the sources of the sounds employed by electronic composers and in their manipulation."

A second machine developed by Dr. LeCaine controls a number of sounds from a chart prepared by the composer. The sounds may be individual sine waves, groups of sine waves, or recorded complexes.

The apparatus was used at the electronic music studio of McGill University in the preparation of two electronic music compositions by Canadian composer Istvan Anhalt. The two compositions were commissioned for Expo 67.

Steacie Prize

Dr. Myer Bloom, 39, of the Department of Physics, University of British Columbia, has been awarded the Steacie Prize for 1967 for his important work in molecular physics.

The prize consists of the income from the E. W. R. Steacie Memorial Fund to which colleagues and friends of the late President of the National Research Council of Canada contributed. It is awarded annually by the Trustees of the Fund for outstanding work done in the natural sciences by younger people.

The Prize, which consists of a cash award of $1,500, was also awarded last year to a University of British Columbia professor—Dr. Gordon H. Dixon of the Department of Biochemistry.

Dr. Bloom is a graduate of McGill University (B.Sc., 1949; M.Sc., 1950) and of the University of Illinois (Ph.D., 1954). He was a Post-Doctorate Research Fellow at the University of Leiden in the Netherlands and more recently a Guggenheim Fellow at Harvard University and an NRC Senior Fellow at the University of Kyoto in Japan.

Avalanche Warning System

Avalanche observer Mike Pittaway, on duty in Glacier National Park, holding a warning transmitter.

When Mike Pittaway presses the button, his co-workers not only jump, they run for their lives.

For Mike, of Revelstoke, B.C., is an avalanche observer in Glacier National Park in British Columbia.

He is one of six trained avalanche observers working with the National Research Council of Canada in the testing of a system designed to get road-clearing crews out of the way of any sudden snow avalanches.

The danger to road crews is real, not imaginary. In 1965 two men were killed by an avalanche at Rogers Pass, B.C. They were attempting to clear the Trans-Canada Highway of snow from one avalanche when they and their snow-clearing vehicles were buried in a second avalanche.

Experience has shown that, in Glacier National Park, there is a maximum period of three minutes from the time an avalanche releases until it strikes the highway. This short period is all that is given to road workers to abandon their slow-moving "cat" or grader and run out of the avalanche path.

To maximize the escape potential of this short span of time, engineers at NRC have devised a plan of action built around modified commercially-available Citizen Band (CB) communications equipment.

A trained avalanche observer is stationed in a safe location up to a mile away from

Snow-clearing vehicle clears Trans-Canada highway near Rogers Pass following an avalanche early in February.

where road crews are working. From here he is able to observe all the trigger areas which may affect that portion of the highway being cleared.

At the first indication of danger, he need only press a button on his modified CB transmitter-receiver to ring an alarm bell in the cab of the snow-clearing vehicle.

The operator must then abandon his vehicle and run for his life.

Off-the-shelf CB equipment was used wherever possible to simplify maintenance and operating procedures. Five-watt transceivers were selected along with a selective calling unit for use in the vehicle. However, it was necessary to add the alarm signal generating capacity to the transceivers used by the avalanche observer. This involved adding two tuning fork oscillators and a push-button switch to this handheld unit.

Work began on this project after the Navigational Aids Section of NRC's Radio and Electrical Engineering Division received a request for assistance from the Department of Indian Affairs and Northern Development which has responsibility for Glacier National Park.

Two vehicles were equipped with the alarm system following an initial testing period in the summer of 1967. Full-scale trials began in mid-October and are to continue until spring, according to George Neal of the Navigational Aids Section, who designed the alarm system.

Avalanche alarm system is mounted beside driver in snow removal vehicle.

Fluidic Anemometer

Mr. Hogue and Mr. Tanney examine a prototype of the fluidic anemometer.

A Toronto manufacturer of customs-made precision instruments expects to generate a quarter of a million dollars in sales with a new National Research Council-designed device for measuring very low velocities of fluids such as air or water.

Champlain Power Products Ltd. expects the first of an estimated 500 Fluidic Anemometers to come off the production line late this spring. Each is expected to sell for about $500.

The Fluidic Anemometer, according to one of its inventors, John Tanney of the Low Speed Aerodynamics Section of the NRC's National Aeronautical Establishment, is capable of measuring air flows ranging in velocity from a high of 10 feet per second down to one-tenth of one foot per second (in water, flow rate measurements of from one foot per second down to one-hundredth of a foot per second).

The lowest range one can hope for with other types of anemometers such as cup, propellor or hot wire, is about a half foot per second in air, Mr. Tanney said.

"There is one other instrument—made up of $3,000 worth of electronic equipment—that measures as low as ours. However, it has a limitation in that it cannot make measurements above half a foot per second."

The Fluidic Anemometer consists essentially of a nozzle and a pair of receiver tubes of a fixed diameter and set a fixed distance apart.

For measurements of air flow, say in a wind tunnel, the anemometer is placed in the airflow. Air at the rate of a fifth of a standard cubic foot per second is directed in the form of a jet from nozzle to receiver tubes.

The flow that is to be measured bends the jet. Displacement of the jet at the receivers produces a pressure difference between them. A pressure gauge or manometer connected to the receivers will then indicate the velocity of the flow.

Ray Hogue, general manager of Champlain Products, says there is a wide range of uses for the Fluidic Anemometer.

"We envision it being used in connection with such things as heating and air conditioning systems, in gas pipeline systems, for air and water pollution studies, in micrometeorology when the need is to know the air currents on forest floors or around growing plants, for wind tunnel experiments, and for river and ocean current studies.

"We even think it has a particularly good potential aircraft application, specifically as an airspeed indicator in vertical take-off and landing aircraft.

"But experience has shown me that its greatest use is probably going to come from where we least expect it," Mr. Hogue said.

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Cover: *Judy Van Laer, NRC Grants Officer, beside a stack of applications for operating grants in the field of chemistry (See story on page 12).*

Direct Current Research

Tractor trailer, shown above undergoing tests at the NRC High Voltage Test Station in Ottawa, was one of several vehicles of various sizes used in a study to determine the potential hazard of leakage currents from direct current transmission lines. The NRC study indicated that for any practical line height there is not a safety hazard.

The Nelson River power project, begun in 1966, will give Canada the distinction of having the highest voltage direct current (900 kilovolts) transmission system in the world.

The first phase of this dc system, scheduled to be completed in 1971 at a cost of $100,000,000, will operate at 450 kilovolts between negative and positive conductors and transmit 810 megawatts along a transmission line running 600 miles from the Nelson River area near Hudson Bay south to Winnipeg. Manitoba Hydro and Atomic Energy of Canada Ltd., representing respectively the provincial and federal governments, are cooperating in the development of the system.

When the total project is completed, they expect the transmission system and its attendant complex of power stations, dams, spillways and hydraulic diversion structures on the Nelson River, the Churchill River, the Rat River and at the northern outlet of Lake Winnipeg to provide 5,000 megawatts—enough power to supply six cities, each the size of Toronto.

Since 1960, the National Research Council of Canada has been conducting research on problems relating to electrical discharge originating with such high voltage dc transmission lines. Such research has determined, among other things, that there is no more hazard to human life from dc lines than there is from conventional ac transmission lines.

Improvements in design of dc equipment have made it economically feasible for dc

A time exposure photograph is necessary to obtain a visible record of the luminous glow produced by the electrical discharge called corona. The above photograph shows the glow produced from positive conductors on direct current test lines at the NRC High Voltage Test Station in Ottawa.

systems to replace alternating current (ac) systems for long distance transmission of energy from remote to urban areas. (The Nelson River project is one of just three dc systems under construction in North America).

However, when high voltage ac or dc transmission conductors are subjected to high surface voltage gradients, an electrical discharge called corona occurs in the adjacent air. This discharge is a major contributor to ionic flow (leakage currents) through the air from line to ground and from line to line.

Until very recently the possible hazards from ionic flow to persons and property in the vicinity of high voltage dc conductors were unknown since no dc systems were in operation outside Europe and these were either of comparatively low voltage or of the underwater cable variety.

With the advent of overland high voltage dc power transmission, the Canadian Standards Association Task Group on Clearances felt it had become necessary to examine this area.

Among objects in closest proximity to such ionic flow will be large trucks and farm machinery passing under transmission lines. Aside from the obvious dangers caused by direct flashover to these vehicles, it was deemed important to know of other hazardous conditions—and uncomfortable physiological effects—which may be encountered at clearances greater than the flashover distance.

This time exposure photograph of direct current transmission lines shows the luminous glows produced by ions originating mainly as corona discharge on negative conductors. The discharge as measured by luminosity is significantly less for negative conductors than for positive conductors (see photo opposite page).

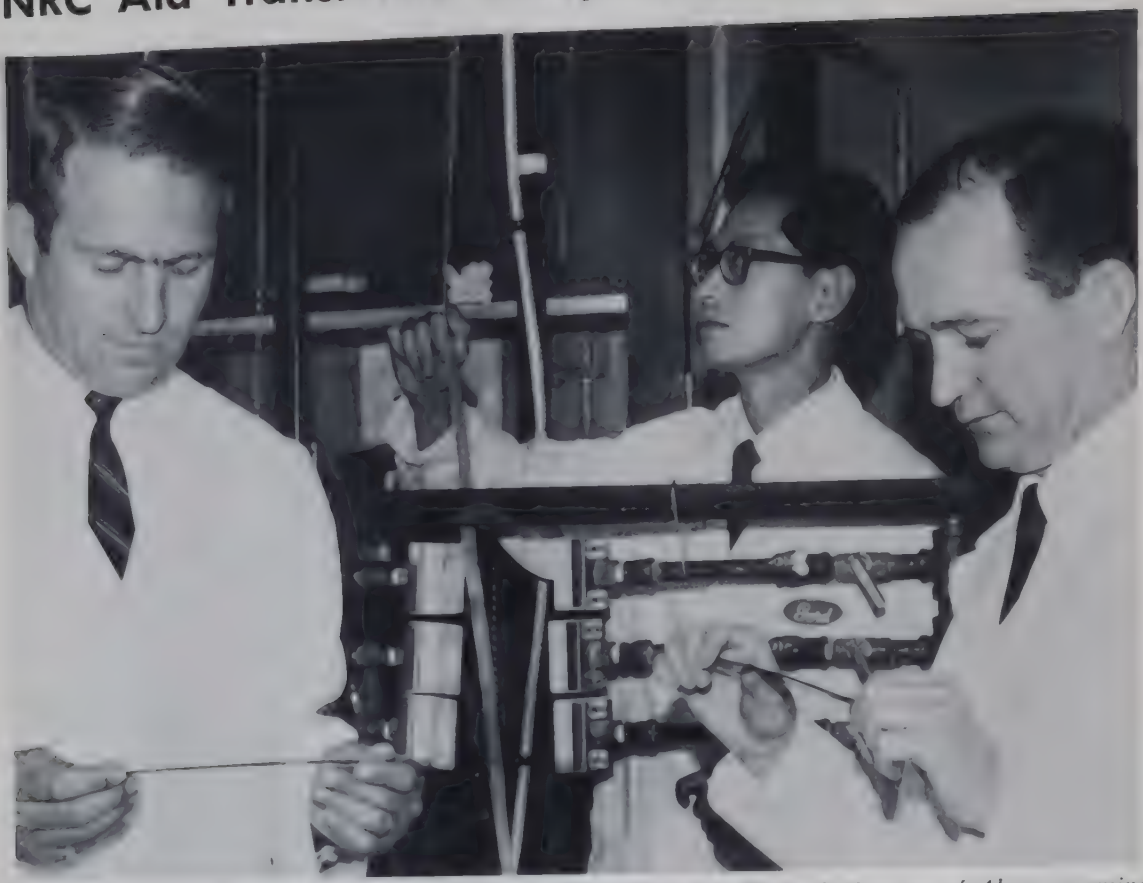
In such cases, ions originating mainly at corona discharges on the conductors will flow to vehicles under the line. The vehicle would build up a charge if not grounded. A voltage appearing on a vehicle, because of intercepted ionic flow, will cause a current to flow in a person who bridges the semi-insulated path from vehicle to ground. Such a bridging would occur, for example when a driver stepped out of his cab after parking beneath dc lines.

Full-scale tests were conducted at the National Research Council high voltage dc test station in Ottawa. In these investigations leakage currents (ionic flow) to large vehicles were measured and consideration was given to possible dangers introduced by voltages and energy storage on these vehicles.

For these tests, several vehicles—ranging in size from a station wagon to a tractor-trailer—were placed in various positions under the dc line and measurements were made under a number of conditions. A bulldozer and a pulley system were used to raise and lower the line.

R. M. Morris of the Electrical Engineering Section of NRC's Radio and Electrical Engineering Division said the test results indicated that, for a dc line at any practical line height, voltages appearing on vehicles and caused by intercepted ionic flow will not introduce a safety hazard.

NRC Aid Transforms Company



Mr. Bailey, Gordon Young, chemical engineer, and Ray Crowne, General Manager of Abrex, examine work on a coil coating machine.

A research and development program, nourished by financial grants from the National Research Council of Canada, has transformed a small Toronto-based company from a run-of-the-mill outfit into an imaginative innovator and exporter of technology and product.

Abrex Specialty Coatings Ltd. of Oakville, Ont., is giving dramatic proof that a small company with NRC assistance can do effective research and development work. Its 13-man research and development group has come up with new water-based resins and application techniques for electrodeposition that are being used for continuous coil coating in Canada and the United States in competition with giants in this field.

Since March, 1965, Abrex has received $171,195 under the NRC Industrial Research Assistance Program. An additional $81,000 has been granted for the 1968-69 period as part of a five-year support program.

Funds provided by the I.R.A. program are used primarily for paying salaries of new research teams in companies where none previously existed, or for new research workers to be added to existing research staffs over and above a company's normal expansion of research effort.

Abrex is one of 87 companies receiving financial assistance under the I.R.A. program. Since its inception in 1962, the program will provide a total of $30,252,000 for the financing for 222 projects. Company costs associated with these projects—primarily for expansion of facilities—will total approximately $41,776,000.

Abrex is a good example of a small private company that has something really hot going for it as a direct result of government research support.

Abrex president G. R. Bailey formed his company in 1963 after a number of years' experience in paint sales and production. He did his own development work and came up with a number of interesting specialty coating products. However, growth was slow. To spur expansion it was decided

o establish a competent technical group and hen aim at getting some of the industrial pecialty coatings business now largely in he hands of non-Canadian firms.

He contacted NRC and was put in touch vith the Chemical Engineering Research Consultants Ltd.—a cooperative group of 6 professors in the Department of Chemcal Engineering at the University of Toronto who are available for advice and research direction.

After 10 months of intensive discussions with CERCL and NRC, Abrex received approval in March, 1965, for an I.R.A. grant. The group took aim at electrodeposition of paint coatings, a field suggested by CERCL as one in which a small company would make a significant short-term contribution without extensive background.

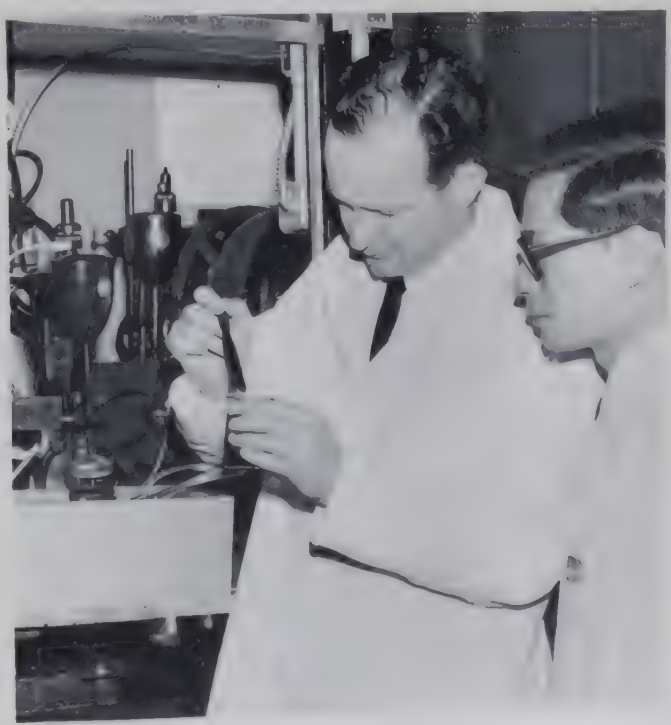
The field was dominated by a few major companies who mainly restricted their coatings deposition work to large objects such as car bodies. Abrex set out to develop a coating suitable for high-speed continuous lines and hit paydirt with a resin and technique which they have applied successfully to coil coating.

Their pilot plant work enabled a major U.S. steel company to install two full-scale production lines at a cost of several millions of dollars. This has resulted in the U.S. company adopting Abrex materials and techniques in its U.S. and Canadian plants and considering their use by other foreign subsidiaries.

In the coating of steel coils, the conventional process uses mechanical type applicators such as rollers, dipping or spraying with a solution-type coating. Mechanical type applicators provide relatively poor uniformity in coating thickness varying by as much as .3 or .4 mils. The Abrex electrodeposition method uses water-based resins to deposit films with a thickness varying by as little as .01 mils. Additional benefits realized from use of the Abrex electrocoating system include: uniformity of film even on sharp edges or complex shapes, faster curing times, simpler clean up, non-inflammability and superior corrosion protection.

The Abrex research and development group is now developing new and improved resins and has recently come up with several water-soluble polymers. The company developed these new products specifically for electrodeposition and is producing them in its plant in Oakville.

The expanded horizons of Abrex have been so encouraging that they have established a manufacturing facility in the U.S., and Mr. Bailey is aiming for a self-supporting research and development group within a few years.



Mr. Crowne and Mr. Young with test device for studying the stability of electrocoating paints. Mr. Crowne is examining a test sample.

Lead shot produced by agglomeration technique is dropped into acid solution for test purposes (left) and forms a slurry (right) when bonding agent disintegrates.

Waterfowl Poisoning Problem

Canadian wildlife officials have been concerned for some time about the number of waterfowl that develop lead poisoning and subsequently die. It is believed that ducks are especially vulnerable and that thousands die annually from this type of poisoning.

Research by the National Research Council of Canada on spherical agglomeration techniques may provide an answer to this serious problem. The process of spherical agglomeration provides a method for making rapid and efficient separations of solids from liquid suspensions. It has been under development since 1958 by the Colloid Chemistry Section of NRC's Division of Applied Chemistry.

The waterfowl poisoning problem is the direct result of spent shot from hunting activities accumulating in marshes where waterfowl feed. About 6,000 tons of lead is deposited annually in waterfowl habitat, and many sites are hunted intensively each year.

Lead-Acid slurry is poured into glass funnel lined with filter paper (left). All that remains of the original lead shot is a fine powder (right).

Waterfowl that probe mud bottoms for food are especially vulnerable. These birds are adept at discarding finely divided solids like mud from their bills but have not yet learned to discriminate between seeds, lead shot and grains of sand.

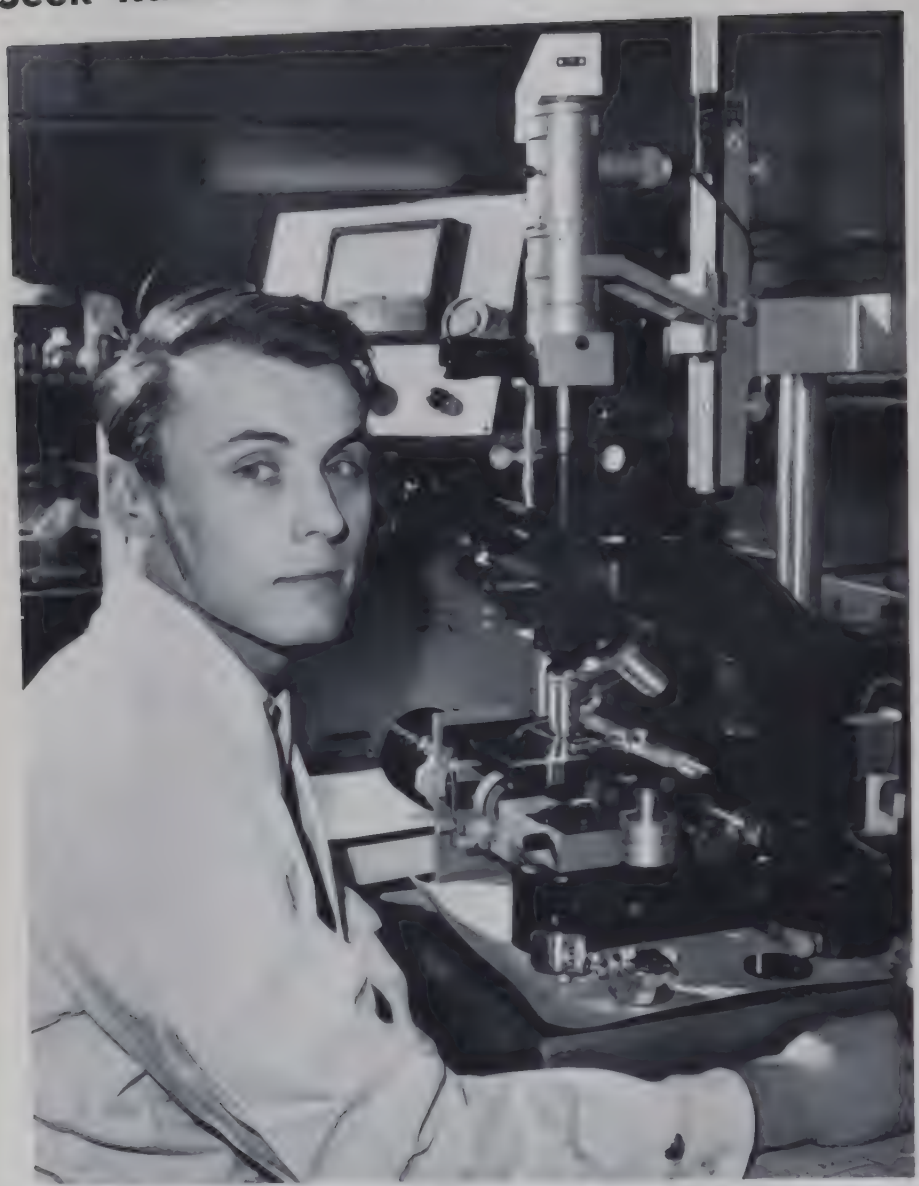
A lead pellet picked up accidentally by a feeding bird finds its way to the gizzard along with other coarse solids. This organ acts like a small attrition mill and the finely divided lead that is produced is slowly dissolved by the digestive fluids and enters the blood stream. It is believed that a single pellet can be lethal.

Proposals to use shot made from nontoxic materials represent a considerable departure from established practice and have not been considered acceptable. The abrasive and ballistic properties of shot made from available substitutes for lead also would almost certainly change in undesirable directions. In addition, the market and cost structure would probably be substantially influenced.

The concept of a lead pellet that would disintegrate to a fine powder on exposure to water has also been proposed in the past. While alloys of lead and sodium, and possibly other elements will do this, they have other serious shortcomings.

However, the spherical agglomeration technique can be used to make acceptable lead spheres, without the conventional shot tower, by agglomerating fine lead powder from its liquid suspension. A water sensitive adhesive such as dextrin or protein glue can be used as a bridging or bonding agent. While this provides a strong structure when dry, the adhesive becomes a parting agent when the lead sphere is exposed to water or to a humid atmosphere over a period of time. Laboratory samples of shot have been prepared that have adjustable disintegration times when immersed in water. Acceptable densities in the finished product also appear to be within reach.

Seek Radiation Antidote



Peter Toelg operating microscope used for estimating the number of cells that are in active division.

A team of scientists at the National Research Council of Canada may be on the verge of a breakthrough in the search for an antidote for the treatment of persons who have received excessive doses of radiation.

The first glimmerings of hope for such a breakthrough comes from research conducted by Dr. James Whitfield, Dr. Helen Morton and Dr. Alan Perris of NRC's Division of Radiation Biology. Their work to date indicates that a relatively simple compound—calcium chloride—may provide the answer.

Calcium chloride has many commercial and industrial uses. However, it is probably best known today as the agent used to keep roads and highways free of ice.

Radiation produced by nuclear and other sources kills by slowing down the process by which cells in human tissue normally divide and replace themselves.

The three NRC physiologists have been working for two years on ways to make bone-marrow cells divide rapidly and still remain functional cells. The vital red blood

cells are produced in bone-marrow, which is the first to feel the slowing effects of radiation. Higher doses of radiation affect the lining of the intestine and massive exposure cripples the nervous system.

Dr. Whitfield says the team made little progress until it was decided to inject calcium chloride into a rat.

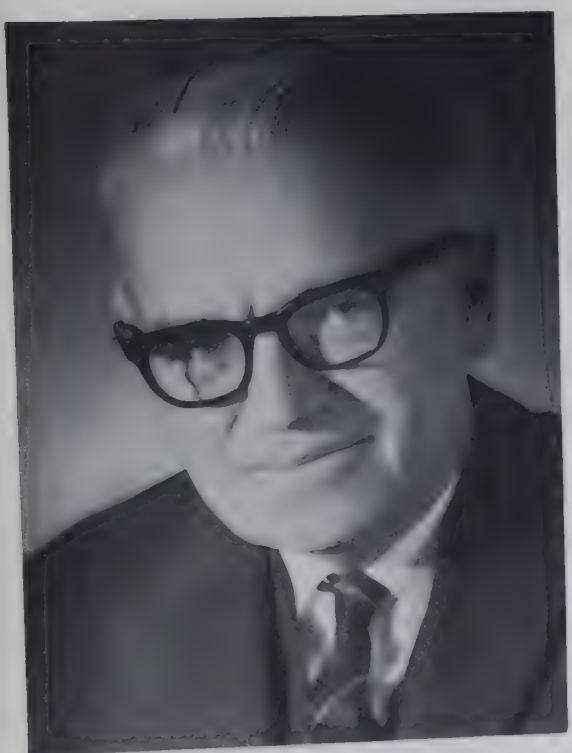
"Much to our surprise the stuff considerably increased normal cell division within the animal's thymus gland and bone-marrow," he says. "It also worked with rats that had been exposed to radiation. Functional cells with normal characteristics were being produced at the end of the chain of rapid cell divisions."

A check on earlier research in this field revealed a connection between the calcium-chloride effect and a hormone secreted by the parathyroid gland in man and animals. The function of this hormone is to maintain the proper balance of calcium within the body. If the calcium level drops below normal, the hormone takes calcium from surrounding bone and feeds it, via the blood system, to cell tissue. Injection of this hormone increases cell division.

The team then tried experiments with a compound marketed under the trade name Versene that is known to reduce the calcium level in the body. It found that if Versene is injected into test animals the calcium level falls and the parathyroid gland is then stimulated into action. Unusual amounts of hormone are secreted and there is a surge of compensating calcium being fed to the body tissues which then stimulates cell division.

"Research done 10 years ago at Chalk River, Ontario, by Atomic Energy of Canada Limited showed that there is some evidence that Versene and parathyroid hormone do have some ability to reduce radiation lethality in irradiated rats," Dr. Whitfield says. "The beautiful thing here is that we are triggering a normal body reaction and not introducing an alien substance into the system. Furthermore, an entirely unexpected and an extraordinarily important dividend now being paid by this work is that this triggered, normal reaction, involving two well-known hormones, is actually a principal control system for the regulation of cell proliferation in various tissues of the body."

The team's work has attracted interest in the international scientific community. Dr. Whitfield stresses that the team is merely on the threshold of "something that could prove very interesting."



Dr. Herzberg

Three New Honors

Dr. Gerhard Herzberg, Director of NRC's Division of Pure Physics, has been elected an Honorary Member of the Optical Society of America in recognition of his "pre-eminent service in the advancement of optics." He is the first Canadian to receive this honor. There are only six Honorary Members of the Society.

Dr. Herzberg also has been awarded the degree of Doctor of Science by the University of Gottingen, Germany, and has been elected an Honorary Fellow of the Chemical Society of London. The only other Canadian so honored by the latter society was the late Dr. E. W. R. Steacie, President of NRC from 1952 to 1962.

NRC Award Program

The National Research Council's research assistance and promotion program for the 1968-69 fiscal year will have a total value of slightly more than $59,300,000. This sum, which does not include funds for industrial research assistance, is an increase of some $13,500,000 over expenditures in 1967-68.

Most of this assistance is centred in Canadian universities in the form of scholarships for outstanding graduate students and research grants for university professors. Funds for this assistance and for other aid to a variety of general scientific programs are provided by a separate Parliamentary appropriation.

G. H. Schut, a member of the Photogrammetric Research Section of NRC's Division of Applied Physics, has become the second Canadian to win the top award of the American Society of Photogrammetry. He has received the Society's Fairchild Photogrammetric Award for the development of "outstanding methods" for the use of aerial photographs in the field of mapping.

The first Canadian to win the award was U. V. Helava, inventor of the analytical plotter, an instrument which ushered in a new era in mapmaking, surveying and satellite photography. He won the award in 1964 when he was with NRC.

Grants to university professors for research projects total about $38,900,000, an increase of $7,300,000 compared with last year. The bulk of this money is awarded to individual investigators as contributions towards the normal operating costs of their research projects.

Postgraduate scholarships and postdoctorate fellowships constitute the main part of the Council's scholarships and fellowships program. A total of 2,218 postgraduate scholarships and 179 postdoctorate fellowships have been awarded for 1968-69, at a forecast cost of $9,500,000.

The Council's "1967 Science Scholarships" are included in this total. Awarded annually to assist outstanding young Canadians to obtain doctorate degrees in science and engineering, they mark the 50th anniversary of the Council's scholarships program and the Centennial of Canadian Confederation.

A total of 50 have been awarded for 1968-69. Recipients receive $5,000 annually for three-year periods, with scholarships being renewable for a fourth year, if necessary. Their academic fees and travel costs are paid by the Council, and the university at which they will study receives an annual grant of $1,500.

This year's assistance to universities for major installations, computers and the development and operation of special research projects will amount to approximately $8,580,000. This sum includes $3,869,000 in new Negotiated Development Grants, a type of assistance initiated by the Council in 1967 to assist universities to develop new or interdisciplinary research centres, particularly in fields relevant to the scientific, economic and resource development of Canada.

Last year the University of British Columbia, the University of Toronto and McMaster University, Hamilton, Ont., received Negotiated Development Grants amounting to $1,200,000, to be awarded over a three-year period. They are designed to assist the three universities to develop and build up more quickly their competence in materials science.

Simon Fraser University, Burnaby, B.C., has been awarded a Negotiated Development Grant of $323,000 to help it establish a national centre to develop methods to combat organisms that damage or destroy

food and forest crops. The university will establish a Centre in Pestology and Pest Management in its Department of Biological Sciences. The NRC funds will be granted over the next three years and the university itself will contribute about $1,000,000 to the centre in the same period.

A grant of $375,000 has been awarded to the University of Calgary over the next three years to permit expansion of the university's Environmental Sciences Centre. The Centre, located at Kananaskis, 50 miles west of Calgary within the Rocky Mountain Forest Reserve, is concerned with research and teaching on the natural environment and, in particular with the interrelations between organisms and their total environment.

Another grant of $600,000 has been awarded to the University of Waterloo to help the university to become a ranking research centre in the field of solid mechanics. In the interest of a planned orderly intensification of effort, funds will be made available in progressively increased amounts over a three-year period. The university will receive $100,000 this year, $200,000 in 1969-70 and $300,000 in 1970-71.

Queen's University, Kingston, Ontario, has been awarded a $300,000 grant for research in pure and applied mathematics. The funds, to be awarded over a three-year period, will be used by the university to strengthen the present high-quality research group in its Mathematics Department. The department's hopes and aims are that it will attain international stature as a research centre in pure and applied mathematics.

A Negotiated Development Grant of $1,367,000 has been awarded to the University of Montreal to help it create a Mathematics Research Centre. Funds will be made available to the university over a five-year period. The Defence Research Board also will provide $10,000 this year and about $100,000 a year over the next four years. The new centre will be entirely concerned with research at the postdoctorate level.

A sixth grant of $724,000 has been awarded to Laval University, Quebec City, to aid its recently established Centre for Research on Atoms and Molecules (CRAM). The Council's assistance to the Centre, where some 25 scientists now are working on the structure and energy of atoms and simple molecules, will be spread over four years. The Centre, developed with the co-operation of the Canadian Armament Research and Development Establishment, will conduct research on some 20 topics, including the structure of different forms of hydrogen and helium, the hydrogen maser, effects of surface energies of ionization and a study in the laboratory and in the upper atmosphere of the excited states of oxygen.

A seventh Negotiated Development Grant of $180,000 has been awarded to Memorial University, St. John's Nfld., to help it establish an Institute for Research in Human Abilities. The sum will be awarded over a three-year period, with the university committing $50,000 to the project. The Institute's main area of interest will be research into theoretical aspects of the acquisition, retention and transfer of information, skills and concepts by people at various ages and stages of educational development.

Dr. R. F. Legget, Director of NRC's Division of Building Research, has been elected by the Geological Society of London as a Commonwealth and Foreign Fellow. This is a special type of membership restricted to a total of 80 persons. Dr. Legget was also elected an Honorary Life Member of the Canadian Construction Association at the Association's 50th annual meeting.

Hydrographic Survey Aid

Mr. Wyslouzil with components of Tone Burst Ranging System. Horn speaker (left) and hand-held walkie-talkie transmitter are aboard mother ship. Microphone assembly, encased in white horn, and receiver-indicator (right) are on side vessel.

The Federal Department of Energy, Mines and Resources soon hopes to be able to speed its hydrographic survey operations on Canada's coastal and inland waters—and save money while doing so.

The Canadian Hydrographic Service is developing a new system for acquiring and processing field data. A key part of the new system has been designed by the National Research Council of Canada and will undergo full-scale tests this summer aboard a government survey ship on Lake Huron.

The system has been dubbed "An Experimental Tone Burst Ranging System for Parallel Line Sounding" by its designers, engineers of the Navigational Aids Section of NRC's Radio and Electrical Engineering Division.

It measures the difference in the time it takes for simultaneously-transmitted radio signals and sound pulses to travel from a "mother" ship to a smaller satellite or "side" vessel. The time interval between arrival of the radio signal and the slower sound pulse is recorded and automatically plotted on a chart calibrated to show the time interval as distance between the two vessels.

At present, each vessel engaged in hydrographic work must carry an exact positioning receiver. These units cost approximately $15,000 apiece. They relate a ship's position to shore stations.

With the NRC system, the only exact positioning receiver in use will be aboard the mother ship. Each side vessel will be linked to the mother ship via the new NRC system which will determine each side vessel's location in relation to the mother ship.

Cost of equipping each side vessel in this manner should be well under $1,000, according to Walter Wyslouzil of the Navigational Aids Section.

Equipment aboard the mother ship consists of a tone burst transmitter and a commercially-available walkie talkie. Each side vessel carries a microphone assembly, a receiver-indicator, a 60-cycle inverter and a radio receiver.

The transmitter uses a horn speaker to send short bursts of sound at a frequency that avoids interference from onboard noise. The walkie talkie microphone positioned next to the horn speaker picks up the sound pulse, converts it into a radio signal and transmits this signal instantaneously to the side vessel.

This radio signal causes a small pin to be retracted in the receiver-indicator, on the side vessel, releasing a light arm which rotates across a band of conductive recording paper at the rate of one revolution per second.

When the slower sound pulse arrives, it causes a fine wire extending perpendicularly from the small arm to burn a mark on the paper whose width of three inches represents a distance of 200 feet.

Operational trials were conducted on Lake Huron during the summer of 1967 with relatively rudimentary equipment, primarily to verify the feasability of the sound through air system.

Adam Kerr, Development Officer in the Marine Sciences Branch of the Energy Department, says this summer's tests will begin with one side vessel and build gradually to a fleet of six. "We have high hopes of success," Mr. Kerr says.

With the NRC system, the cost of operating a side vessel would be cut by about $14,000 and permit an increase in the rate of data collection which is an integral part of the operation.

Dr. R. Norman Jones, head of the Organic Spectrochemistry Section of NRC's Division of Pure Chemistry, has received the 1968 award of the Spectroscopy Society of Pittsburgh. This award, given annually at the Pittsburgh, Penn., Conference on Analytical Chemistry and Applied Spectroscopy, is for distinguished contributions to pure and applied spectroscopy.

Dr. James M. Roxburgh has been appointed first full-time Secretary of the Medical Research Council. Until his appointment on April 1, Dr. Roxburgh was with the Awards Office of NRC, administering the Council's Scholarship and Fellowship Program.

Canadian industry is starting to show a major interest in the National Research Council's National Science Library as a source of scientific and technical information.

In recent months the Library's primary function—the processing, retrieving and dissemination of scientific and technical information—has reached noteworthy proportions, says Dr. J. E. Brown, Chief Librarian.

There has been a rapid increase in the number and type of enquiries received from a growing range of industries in Canada, the United States and other countries. However, despite this increase many organizations and individuals, who could profit from the use of the Library, still are unfamiliar with the services available to them without charge.

During a recent two-month period, the Library, which has amassed one of the world's outstanding collections of scientific and technical literature, made an analysis of information requests received in this period. The type of assistance requested fell into four main categories—requests for scientific and technical information or data, for literature searches on specific subjects for a given period of time, for compilation of bibliographies, and for identification and location of obscure references and publications.

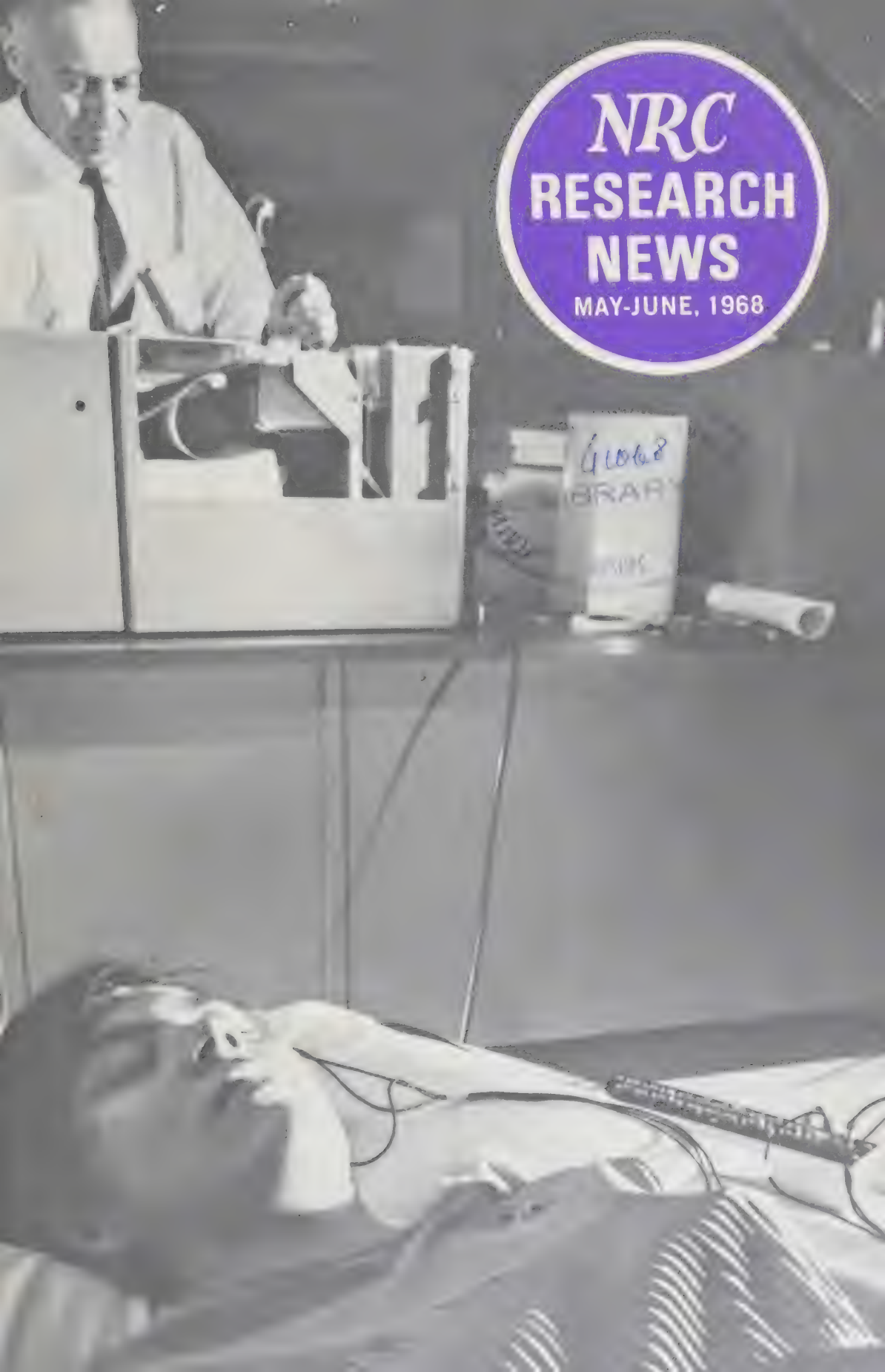
In the two-month period, the Library received 2,750 requests, an average of 67 a day, for assistance in these four categories. The time required to answer each request ranged from 15 minutes to seek out some quantitative data, to several days to compile a bibliography on a specific subject covering the literature over a 20-year period.

Of the 2,750 requests, 50 per cent were from industry, 30 per cent from universities and 20 per cent from federal and provincial governments, public libraries and individuals. These requests do not include an equal number from NRC scientists, or the 300 or more requests received daily for loans and photocopies of scientific and technical publications.

A spot sampling of 30 letters shows that the companies involved represent many of Canada's main industries. They included companies in electronics, manufacturing, construction, mining, petroleum, pulp and paper, glass, engineering, power, surveying, aircraft and clothing.

One company asked for a bibliography on all earthquake literature. Another asked for available literature on tidal power development in Russia.

A manufacturing company asked the Library for assistance in providing one of its officers with material for an important speech to be delivered behind the Iron Curtain. Another asked for information on how to set up a technical library, while others sought information on protective clothing, plastic forming techniques, job evaluation, micro-fibre filters, effect of wind, humidity and temperature on sound speed, ice pressure effects on pilings of river bridges, rink construction, low-cost housing, metallurgy, paving asphalts, mining methods and a number of production techniques.



NRC RESEARCH NEWS

MAY-JUNE, 1968

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Cover: Dr. G. J. Thiessen with electroencephalograph used to record changes that nuisance noises make in the brain wave patterns of sleeping subjects. Nancy Covington, Dr. Thiessen's assistant, poses as sleeping subject.

Mapping Guatemala's Rainforest

NRC helicopter lifts off . . .

Tests conducted recently in the tropical forests of Central America indicate that a Canadian developed radar altimeter can be of great value to the developing countries of Africa, Asia and Latin America in surveying their forest resources.

The forestry radar altimeter was developed by the Radio and Electrical Engineering Division of the National Research Council of Canada at the request of the Forest Management Institute of the Department of Forestry and Rural Development.

It has been used successfully in Canada for forest surveying by means of low-level aerial photographs, that is, taken at between 500 and 2,000 feet. Precise readings of altitudes above ground level are a prerequisite for extracting quantitative information about a forest area from aerial photographs. For convenience and to ensure

. . . to survey tree-clad mountains.

Mr. Wood at controls of helicopter.

perfect synchronization, the radar altimeter reading appears in the corner of each photo.

The altimeter also appears promising for use in other fields such as magnetometer surveys and low altitude topographic mapping, and it is now being manufactured by Leigh Instruments Ltd., of Carleton Place, Ontario.

The outstanding feature of this altimeter is its ability to measure actual flying height above the ground without being affected, like normal radar altimeters, by intervening vegetation. As well, it can be easily installed in light planes or helicopters.

At the invitation of the Food and Agricultural Organization of the United Nations, which became interested in the potential value of the Canadian radar altimeter and low-level aerial photographic technique for surveying the forest resources of developing countries, a Canadian team went to Guatemala in March to test the altimeter under tropical forest conditions.

The Flight Research Section of NRC's National Aeronautical Establishment undertook operational responsibility for the tests and supplied a Bell 47G helicopter. Radar experts from the Radio and Electrical Engineering Division installed and operated the altimeter, and the Forest Management Institute planned and analysed the aerial photography aspects of the tests. Field facilities were provided by the F.A.O. The National Research Council, the Department of Forestry and Rural Development, Canadian Patents and Developments Ltd. and Leigh Instruments Ltd. shared the costs of the expedition.

Tests were conducted over a period of six days, from an F.A.O. camp near the village of Sayaxché in northern Guatemala. This is an area of typically lush tropical rainforest.

The altimeter proved largely successful in penetrating the main tree canopy of the tropical forest, but some difficulties were encountered in penetrating the last 20 feet of short trees, palms, vines and shrubs which are characteristic of such forests. However, the radar experts believe further modifications and adjustments to the altimeter can overcome most of these difficulties and work is continuing to that end.

The initial accuracy requirement specified for the altimeter by the Forest Management Institute was two per cent of flying height or better. The altimeter has met this requirement easily in Canadian forest surveys, but

Trunk of fallen forest giant provides resting place for survey crew members.

fell short in the tropical test when over solid forest cover. However, it met the specified standard when over clearings.

The aerial photography trials also gave a clear indication that large-scale aerial photography is a most promising technique for identifying tropical tree species, as many tree specimens could be identified by their characteristic crown shape, branching habits and leaf shape. This overcomes a major drawback encountered in the past in attempting to recognize tree specimens on small and medium scale photography.

The tests also showed that the system of large-scale photography integrated with the radar altimeter is a very promising new approach to the measurement of trees in tropical forests.

The Canadian team included A. H. Aldred and L. Sayn-Wittgenstein of the Department of Forestry; F. E. Alie and R. L. Westby, of the Radio and Electrical Engineering Division, and R. J. Page, L. Ingle and A. D. Wood of the National Aeronautical Establishment. Mr. Wood piloted the helicopter.

The helicopter was dismantled in Ottawa and packed in specially constructed boxes for transport by road and air-freight to Guatemala City, about 155 miles south of Sayaxché. The aircraft was assembled in Guatemala and flown to Sayaxché on March 13. The test program started the following day and continued daily until March 19, with the exception of one day when the aircraft was not flown.

The return flight to Guatemala was made on March 20. The helicopter was dismantled and packed by March 23 and the last members of the team left Guatemala for Ottawa, March 26. The helicopter arrived in Ottawa by truck April 2.

Partially restored temple known as El Ceibac—in heart of rainforest.

Sleep-Sound Study

Dr. Thiessen examines brain pattern charts.

A person who allows himself to be lulled to sleep by a quietly-playing radio may be harming himself without knowing it.

This is a preliminary finding of National Research Council of Canada scientists using a new high-speed method of analysing the effects of noise, such as from traffic, on sleeping subjects. The NRC method permits eight hours of recorded brain wave patterns to be scanned in five minutes and is expected to eventually gain wide acceptance as an analytical instrument in other areas of sleep research.

While the number of subjects studied is still small, it is clear that levels of noise as low as 50 decibels (the rating of a quiet radio) can disturb a sleeper without actually awakening him. The nature of the disturbance involves a change from a deep to a shallower sleep and this is known to be deleterious to a person's well-being.

In the NRC studies, sleeping subjects are exposed to prerecorded sounds in the "nuisance" noise region below the 85-decibel level—the point above which hearing loss can be sustained and measured.

An electroencephalograph is used to record the sleeping subject's brain waves since this instrument is an excellent indicator of a subject's depth of sleep and hence of the degree to which a noise can disturb this condition.

The EEG signals are recorded on magnetic tape rather than on the standard electroencephalograph chart. The tape is slowed down during the recording period. During the playback, the tape is run through at 50 to 100 times the recording speed and the EEG signals can be analysed and recorded by a sound level recorder which retains the gross features indicating the depth of sleep.

This procedure permits an investigator to take an eight-hour EEG recording and scan

it for meaningful data in less than 10 minutes.

Dr. G. J. Thiessen, Head of the Acoustics Section of NRC's Division of Applied Physics, said the NRC method eliminated the vast volume of paper work that would have resulted if conventional EEG recordings had been taken of several subjects eight hours a day for months on end. Initial work indicates it shows promise of injecting an element of objectivity into a field where decisions (or laws) have been based on subjective judgments, he said.

Because of the great contraction of time, not all the information on the original recording is retained. However, the continuity in time is retained and this provides a good picture of the progression of a person's sleep.

In scanning the tape recording, the investigator tries to determine when EEG signals change in ways that are characteristic of alterations in the sleep pattern. When the signals are fed to a loudspeaker, the major changes in sleeping conditions are readily audible.

Knowledge about sleep accumulated during the last decade makes it possible to investigate the effects of sounds on sleeping persons in a scientific manner that would not have been feasible a few years ago.

Among other things, the various stages of sleep have been related to differing EEG patterns; the alpha rhythm of drowsiness; the somewhat irregular, low amplitude waves of Stage 1 sleep; the "spindles" and larger fluctuations of Stage 2; the irregular, large slow waves of Stage 3 and the larger, slower waves of Stage 4.

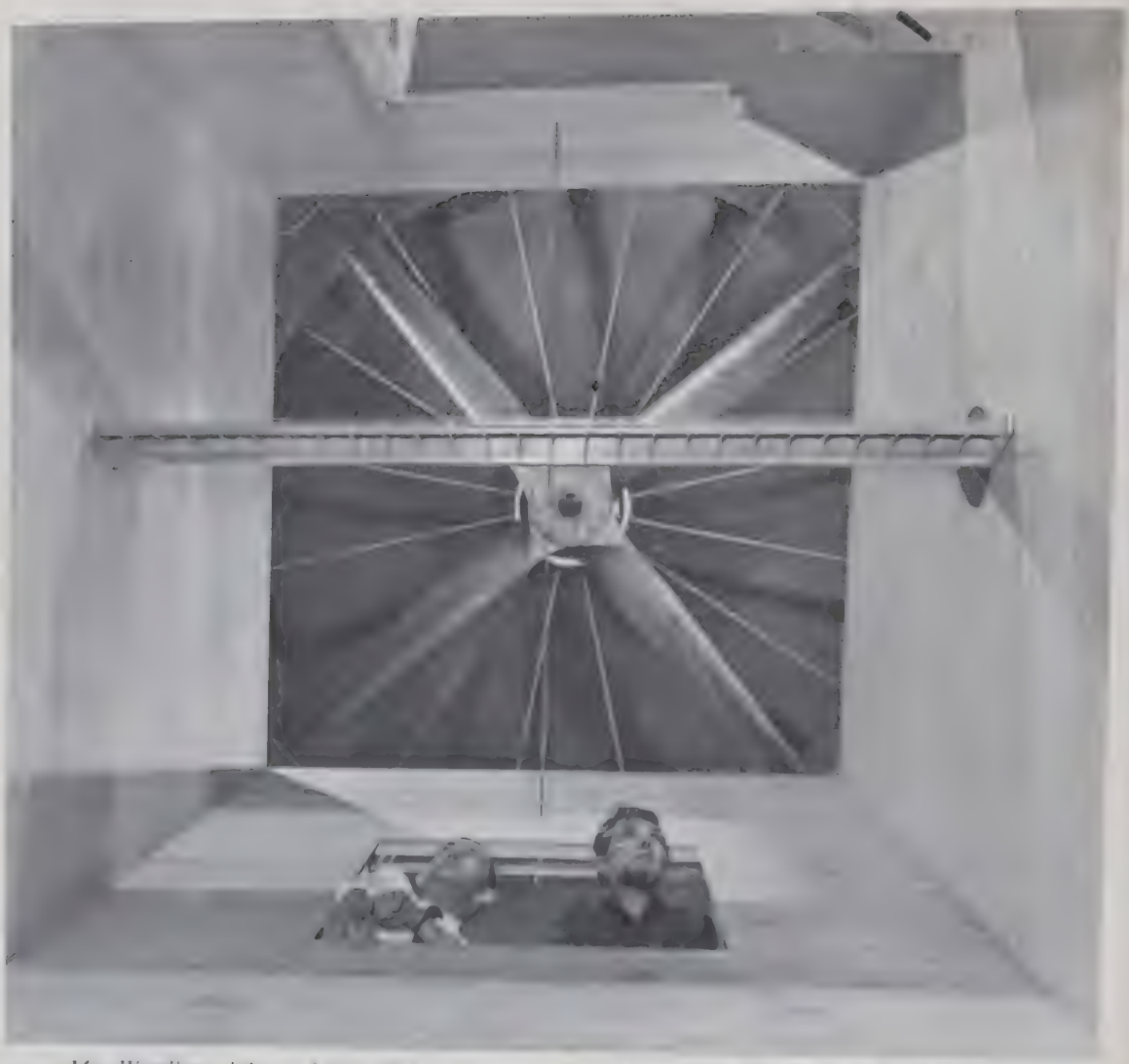
By studying the extent to which these rhythms can be interrupted by different types and intensities of sound, Dr. Thiessen hopes to find new clues concerning the effect of noise on sleepers—effects which the subject is probably not aware of.

One such effect is expected to show up as psychological damage caused by noise disrupting dreaming. Dreaming takes up about one-third of everyone's normal sleep time. It is deemed essential to mental health. People deprived of dreams become nervous and irritable and within 10 days, their personalities begin to change.

Honored

Dr. W. G. Schneider, President of NRC, received Honorary Doctor of Law degrees from the University of Alberta and Laurentian University, Sudbury, Ont.

Dr. C. J. Mackenzie, a former President of NRC, was named 1968 winner of the $50,000 Royal Bank Award. He also was named a Companion of the Order of Canada.



Mr. Wardlaw, left, and Mr. Reimer examine bridge model in NRC wind tunnel.

Artist's conception of proposed bridge to span the Rivières des Pra

Wind Tunnel Tests for New Bridge

Wind tunnels operated by the National Research Council of Canada are used primarily for aircraft research and development. However, they now are being called on to an increasing extent for many other studies, including the effect of wind on transmission towers, bridges, buildings and antenna masts.

An NRC research project now in progress involves a series of tests on a model of a section of the centre span of a new type of bridge that will be built in the Montreal area for the Quebec Provincial Government. It will span the Rivière des Prairies in the north end of Montreal, linking Papineau Avenue with Leblanc Boulevard in Laval, Que.

The bridge will be what is known as a cable-stayed bridge, a design concept pioneered in West Germany some 15 years ago. In bridges of this type, (see photograph below) the bridge girder of the centre span is stayed or supported by steel cables attached to two slender towers. They are considered to be economical for main spans ranging from 600 feet to 1,200 feet.

the north end of Montreal.

The six-lane 92-foot wide bridge will be 1,380 feet in length and will consist of a centre span of 790 feet and two approaches each 295 feet in length. The bridge centre span girder will be carried by cables which are supported by the bridge's two 126-foot high towers.

The consulting engineers for the bridge, Gendron, Lefebvre & Associés of Laval, Que., asked the Low Speed Aerodynamics Section of NRC's National Aeronautical Establishment to test the bridge design for its aerodynamic properties. This work is being conducted by a team headed by R. L. Wardlaw, an aeronautical engineer, and including Harvey Reimer, and Mrs. Lillian Goertler, technical officers.

Mr. Wardlaw says the tests, the first of their kind in Canada with this type of bridge, are designed to determine the centre span's ability to withstand various types of wind loads.

For this purpose a plywood model representing a 336-foot section of the centre span has been built. The model, built by S. R. Graham, a technician, is seven feet long and 22 inches wide and is built to a scale of one forty-eighth of the centre span section.

"The object of the tests is to determine the velocity ranges at which wind-excited vibrations occur in the centre span section, the amplitude of such vibrations and also the types of vibrations—whether they are of a bending or twisting nature," Mr. Wardlaw says.

Such vibrations, unless they are of an extremely serious nature, will not destroy a bridge. However, too much vibration over a long period of time could damage the bridge and also represents a performance problem from a user's point of view. An amplitude, for instance, of two inches would be acceptable, but one of nine inches under extreme wind conditions would be serious.

The bridge model is being tested in NRC's 15-foot vertical wind tunnel, which simulates wind velocities of the type the actual bridge will experience, and also velocities far in excess of what is expected—up to 120 miles an hour.

"The amplitude and nature of vibrations at various wind speeds are recorded electronically for later analysis," Mr. Wardlaw says. "Information obtained in the tests will be given to the consulting firm and will be used to determine whether the bridge design is satisfactory."

New Rocket Launcher

Building housing the new launcher.

The National Research Council of Canada will boost the rocket firing capabilities of its Churchill Research Range this summer when it takes delivery of a $500,000 Auroral Rocket Launcher.

This new 45-foot high launcher, based on an NRC concept, is expected to be in operation in August—in time to take some of the workload off the four existing major launch facilities at the Churchill, Man., rocket range.

The range is operated by the Space Research Facilities Branch of NRC in cooperation with the National Aeronautics and Space Administration of the United States. It is used primarily for research of the upper atmosphere and in studies of the Aurora Borealis, magnetic fields, meteorology and other geophysical effects. It is also used for rocket vehicle research testing, and functions as a launch site for the World Meteorological Rocket Network.

SRFB officials anticipate 1968 will be the range's busiest year. A total of 411 rockets and balloons are scheduled for launching, more than double the 1967 figures.

Of the 339 rockets to be launched, 110 are major vehicles such as the Canadian-built Black Brant family of rockets, the U.S. Javelin, Aerobee and Nike series and the smaller British-built Skua. The remaining 229 are small meteorological sounding rockets provided by NASA as a contribution to the World Meteorological Rocket Network.

The major rockets carry scientific payloads ranging in weight from 60 to 500 pounds to altitudes of 80 to 600 miles in order to study auroral events which among other things, cause disturbances in radio and telegraphic communications.

The new auroral launcher is designed to handle rockets up to 38 feet in length and weighing up to 4,000 pounds. It is expected to bring about a significant improvement in the range's ability to react swiftly in the winter months during short duration auroral events.

In winter, it is necessary to keep the rocket and its scientific payload at normal temperature until launch time. Existing launch facilities meet this requirement by the use of moulded fibreglass clam-like heat shields. These enclose the rocket. Then the launch building is opened and the launcher is elevated and placed into final launch setting. Heat is forced through the enclosure made by the heat shields, keeping rocket and payload warm while it is exposed awaiting suitable launch conditions.

The new launcher eliminates the need for heat shields through quick opening and closing of rocket exit and blast relief doors and through a fast reheating capability. The launch building is specially constructed to

Ex-Vancouverite Dr. K. A. Dick of Johns Hopkins University at work on scientific equipment aboard Convair 990

permit the operations of assembly, elevation and final setting of the rocket to be conducted indoors. The building remains tightly sealed until just prior to the launch itself.

Activity at the range so far this year includes the launching of 11 Black Brant rockets and four Skua rockets, all part of the 1968 Canadian Sounding Rocket Program. A total of 27 major Canadian launchings are scheduled for 1968. There were eight launchings in 1967.

Scientists from NRC, the Defence Research Telecommunications Establishment and the universities of Western Ontario (London, Ont.), York University (Toronto, Ont.), Saskatchewan (Saskatoon, Sask.), Calgary (Calgary, Alta.) provided the scientific payloads for the 11 Black Brants. Four were launched in January, one in March and six in April. These carried equipment for 124 separate experiments.

Scientists from York University provided equipment for seven experiments into atmospheric composition carried out with four Skua rockets.

The remainder of the 1968 Canadian Sounding Rocket Program—including two Black Brants to be launched from NRC's Resolute Bay Rocket Launching facility—is to be completed this fall when auroral conditions are improved due to longer periods of darkness. Scientists from the University of Montreal, the University of Toronto and Dalhousie University (Halifax) will be among those participating in this phase of the program.

Early this year the Churchill Research Range was the site of the first co-ordinated aircraft-rocket-satellite study of the aurora. A NASA Convair 990 jet aircraft, outfitted as a flying laboratory, was used in two three-week sessions to carry scientists from 13 universities and research institutions across the auroral belt. Measurements were taken simultaneously from the aircraft, from the nose cone payloads of five rockets launched from the range and from equipment on the OGO-4 satellite.

This unique experiment, one of the most ambitious of auroral studies, is expected to yield preliminary results later this year.

NASA Convair 990 in front of DOT hangar at Churchill.

Marine Coupling Devices

Mr. Mathews, left, and Mr. Kawerninski, with model tugs and barges hooked together with marine couplings. Models in foreground illustrate towing arrangement. At rear, pushing arrangement is demonstrated.

Coupling arrangements that can be used for close-hauled towing or pushing of barges by tugs or similar vessels have been developed by the National Research Council of Canada.

Known as marine couplings, they were designed by the Ship Laboratory of NRC's Division of Mechanical Engineering. They have the potential for a major improvement (provide a greater degree of control) over present methods of towing barges with long cables and also pushing barges connected to tugs with rigid structural members.

In present marine towing operations in the open sea, relatively long tow-lines must be used between the barge and the tug and between individual barges. In some instances, it is necessary to use towing cables up to one mile in length.

The purpose of the long cables is to permit towing with safety by reducing the danger of waves and wind propelling the barge into the tug. Long towing cables also provide elasticity during sudden relative movements between the towed and towing vessels. Shorter cables have been tried but in rough water they break because of lack of "sag" to absorb sudden relative movements between vessels.

The use of long towing cables also creates serious navigational problems, especially when towing barges through narrow straits or around corners and when attempting to stop the towed vessel. In addition, currents and winds tend to take control of the barges.

In present marine pushing operations in protected waters, the tug and the barges are tied together in such a way as not to allow relative motions between the vessels. For operations at sea this would result in high stresses developing in the connections.

The new NRC-designed marine couples meet the need for a more practical method for both the towing and pushing of barges at sea. It involves the use of a single pneumatic telescopic structural member extending between the vessels and which is connected to one of the vessels by a type of universal joint, allowing relative heave,

NRC's 450-foot long towing tank was used to test marine coupling devices. Model barges used in the tests ranged from 11 to 15 feet in length.

pitch, roll and yaw and surge. In sheltered waters such as narrow straits and canals, the towing connection can be simplified.

The new couples were invented by S. T. Mathews, Head of the Ship Laboratory, and L. I. Kawerninski, an engineer with the Laboratory. They have been patented by Canadian Patents and Development Limited, a subsidiary of NRC.

In pushing operations, the tug and all barges are interconnected with a marine coupling. In towing operations, it is still recommended that the tug be connected by a cable with the first barge it is towing. The length of the cable will be determined by weather and sea conditions. In both cases all the barges will be interconnected with a pneumatic towing connection, giving the tug improved control over the barges.

For tugs pushing barges the pusher coupling can also be activated for use by the tug as a steering device.

In operations in waves, relative longitudinal motion between vessels is overcome by using a towing bar with an integral telescoping unit and this feature could be omitted in sheltered waters. In an earlier design, produced by the Ship Laboratory, coil springs were used as the elastic element to transmit the towing or pushing forces, but tests determined that a pneumatic system would be more suitable because of its non linear stiffness characteristics, and also the difficulties in obtaining coil springs in large sizes. The pneumatic device then showed better possibilities for practical applications.

The marine coupling was tested by the Ship Laboratory between two barges built to scale to represent vessels of 2,500 tons displacement and 200 feet in length. The leading barge was towed in the Laboratory's 450-foot towing tank with a length of cable corresponding to 500 feet. Wave lengths of 280 feet and barge speeds of 6½ knots were simulated in the tests.

Marine couplings of various simulated lengths were tested in the towing tank. These tests showed that good results were obtained with couplings which were about 20 to 25 per cent the length of the towed vessel and so for a barge of 200 feet the length of the coupling would be some 40 feet.

The general model arrangements of the pneumatic marine couplings involve a piston and a pressure equalizing chamber. While the principles of the model can be applied to full-scale installation, details of construction of an actual coupling would be different and an engineering specification would have to be prepared.

One of the obvious difficulties of a pneumatic towing device is the possibility of leakage on one side or other of the double acting piston and a creeping of the mean position of travel away from the centre of the system. This difficulty has been overcome by the incorporation of the pressure equalizing chamber around the centre of the cylinder. As the piston passes this chamber, holes in the side of the cylinder connect both halves of the cylinder through the chamber, and so every time the cylinder passes the mid-position the pressure on both sides of the cylinder is equalized.

Another feature of this pneumatic arrangement is that its stiffness is easily adjusted while running by changing the pressure inside the cylinder through an opening along the centre of the piston rod. This feature makes possible a greater degree of control over the navigation of multiple close-hauled barges.

Low Pressure Research

Jill Baker Displays Magnetron Gauge.

How do you measure the number of gas molecules in a given volume of interstellar space?

That's a task for space scientists of the far future and today at the National Research Council of Canada, engineers are on the road to devising instruments capable of doing just that.

The Electron Physics Section of the Radio and Electrical Engineering Division of NRC is an acknowledged world leader in the use of ultrahigh vacuum techniques for the production and measurement of very low pressures.

One of their instruments, the magnetron gauge, has been modified for inclusion in a package of instruments to be left on the moon's surface by United States astronauts as part of the Appollo manned flight-to-the-moon project.

This gauge is expected to perform a "total pressure" measurement which, it is hoped, will determine more fully the effect of the solar wind on the lunar atmosphere.

Present theories hold that the solar wind tends to sweep away all light gases, leaving an atmosphere composed almost entirely of very heavy inert gases. These are believed to originate from radioactive decay of material on the moon's surface. If sufficient measurements can be obtained, it may be possible to place an upper limit on the strength of the solar wind. Space scientists hope this will serve to some degree to verify existing theories currently in conflict to some extent.

Another version of the magnetron gauge previously was used to take measurements from aboard the U.S. Explorer 17 satellite.

An earlier device from the Electron Physics Section laboratory was re-engineered by the Russians and placed aboard the Sputnik series of earth satellites.

These instruments are two of a series devised over the last decade as the Electron Physics Section sought the outer limits of low pressure production and measurement through the use of ultrahigh vacuum techniques.

Ultrahigh vacuum technology is used for

E. V. Kornelsen uses an ultrahigh vacuum ion gun to study the entrapment of ions in metal crystals.

the simulation of extra-terrestial conditions in the laboratory. It is also used for the study of the interaction of gases, charged particles and radiation with surfaces; for the preparation of extremely pure solid films; for experiments in very pure gases; and in certain types of accelerators and storage rings where loss of high energy particles by collision with gas molecules must be minimized.

Two years ago the Electron Physics Section, headed by P. A. Redhead, reported the production and measurement of pressures as low as 5×10^{-14} Torr, which is roughly the equivalent of that found in interplanetary space.

(The Torr is the standard unit in vacuum technology. It is defined as the pressure necessary to support a column of mercury one millimeter high. In ultrahigh vacuum technology the extremely small pressures are most conveniently expressed in negative powers of 10. The fraction one-tenth is written 10^{-1}, one hundredth is written 10^{-2} and so on. Thus 10^{-8} would be one divided by 100 million.

5×10^{-14} Torr is about 10^{-18} the pressure of the atmosphere. This means that only one out of every billion billion air molecules originally present in the vacuum chamber is left after ultrahigh vacuum pumping.

At a pressure of one atmosphere each molecule travels an average of a few millionths of a centimeter before bumping into another molecule. At 5×10^{-14} Torr, if it were not for the walls of the vacuum chamber, a typical molecule would travel about 600,000 miles before colliding with another molecule.

Mr. Redhead estimates his section has refined UHV techniques, partly through the use of cryopumping, to the point where it is able to create pressures as low as 10^{-27} Torr, approximately that found in interstellar space.

"Our theories indicate that we can produce pressures as low as 10^{-27} Torr, but there's no way of proving it since we haven't been able to measure pressures this low, nor do we see such measurements being possible in the near future," he said.

"The best we have been able to do in pressure measurement is 5×10^{-14} Torr at room temperature. But, to our knowledge, there isn't a laboratory in the world that has duplicated this feat," he said.

While its instruments have been adapted successfully to space research, Mr. Redhead's section is concerned primarily with the development of techniques and instruments for what has come to be called Surface Science.

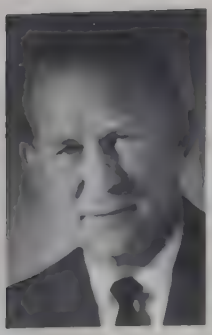
Here the objective is to obtain by a variety of methods an atomically clean surface so that it can be examined for its properties and experiments performed on it for a fairly long period of time.

"At a pressure of 10^{-6} Torr the surface to be examined would be covered with a monolayer (a layer of gas molecules one atom thick) in less than one second. If the pressure can be reduced to 10^{-12} Torr there is a millionfold increase in time. Instead of a second, the scientist now has 10 days during which the surface stays clean."

A score of instruments have been developed by the section since 1958. Licences for exploitation of several of these instruments have been granted to companies in the United States, West Germany and the United Kingdom through Canadian Patents and Development Ltd., a subsidiary of NRC.

"Unfortunately, we haven't made any impact on the Canadian economy so far, largely because until recently there wasn't a Canadian company manufacturing vacuum equipment."

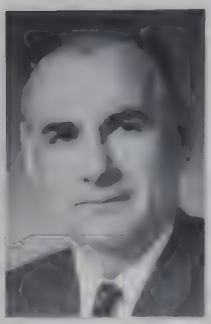
Mr. Redhead said the section's latest instrument, known as an Extractor Gauge, is currently being examined by companies in the U.K. and the U.S. He estimates a potential sale for this instrument of 200 to 300 annually. Each unit, together with control circuits, is expected to cost approximately $1,000.



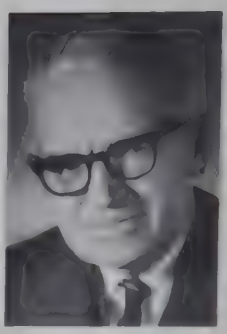
Mr. Blachut

Dr. Cook

Dr. Craig



Mr. Green



Dr. Herzberg

Dr. Legget

Dr. Makow

Dr. Morrison

Mr. Schut

T. J. Blachut, Head of the Photogrammetric Section of NRC's Division of Applied Physics, recently described advancements in photogrammetry at a number of leading American Universities. His lecture program was sponsored by the National Science Foundation of the United States.

Dr. W. H. Cook, Executive Director of NRC, has been elected President of the Biological Council of Canada, founded in 1967 to promote biological research in Canada.

Dr. B. M. Craig, of NRC's Prairie Regional Laboratory, Saskatoon, is participating in a co-operative food technology project sponsored by the U.N. Food and Agriculture Organization and the University of Chile. Aim of the project is to strengthen university facilities in the area of food technology and food industry development.

The Standards Engineering Society has conferred the grade of Fellow on Eric Green of NRC's Division of Applied Physics "in recognition of his important accomplishments in the field of calibration and verification of primary standards and his major contributions to standardization on both national and international levels."

Dr. Gerhard Herzberg, Director of NRC's Division of Pure Physics, has been elected a Foreign Associate of the National Academy of Sciences in Washington.

Dr. R. F. Legget, Director of NRC's Division of Building Research, was awarded the Medal of Service of the Order of Canada.

Dr. David Makow of the Photogrammetric Section of NRC's Division of Applied Physics, was elected a Fellow of the Institute of Electronic and Radio Engineers.

Dr. J. A. Morrison, Director of NRC's Division of Pure Chemistry, was named 1968 winner of the Chemical Institute of Canada Medal. The 18th winner of the medal, he has made his reputation mainly through work in the field of thermodynamics of the solid state. The medal is donated annually by the International Nickel Company of Canada Ltd. and is made of pure palladium.

G. H. Schut of the Photogrammetric Section of NRC's Division of Applied Physics, recently visited Jamaica to advise Jamaican authorities on scientific and technical questions concerned with modern mapping techniques.

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SEPT.-OCT., 1968

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Cover: Section of the St. Lawrence River model from Trois Rivières to Quebec City.

St. Lawrence River Study

Mr. J. Ploeg of the Hydraulics Laboratory and Dr. Ince travel length of river model on an electric golf cart.

Hydraulic engineers at the National Research Council of Canada are participating in a co-ordinated program with the Department of Transport to improve the St. Lawrence River waterway for its future role in shipping.

Tidal hydraulics investigations being conducted by the two Federal Government bodies are necessary to promote scientific research of the tidal phenomena. The studies also are necessary in the investigation and development of engineering projects which might form part of the Transport Department's over-all planning for river improvement to meet the growing needs of modern shipping and permit safe, efficient marine traffic.

One of the highlights of the studies involves research being conducted by the Hydraulics Laboratory of NRC's Division of Mechanical Engineering. The laboratory's main research tool is a giant new tidal model of the St. Lawrence River from Montreal 350 miles downstream to Father Point, near Rimouski, Que.

Housed in a two- and three-storey building that stretches the length of two city blocks, the St. Lawrence model will be 750 feet in length and will measure 75 feet at its widest point. It is so large that its staff of five engineers and six technicians will use an electric golf cart to check measuring instruments located along its entire length.

The first stage of the model—between

Mr. Ploeg and Dr. Ince inspect a section of the model at Grondines, halfway between Trois Rivières and Quebec City.

Montreal and Quebec City—was begun in 1966 and has been completed. Experiments now are in progress over this section. The second stage from Quebec City to Father Point is expected to be completed in January, 1969, with the entire model being operational the following July.

Dr. Simon Ince, Head of the Hydraulics Laboratory, says the hydraulic resistance of the St. Lawrence River has been lessened as a result of many years of dredging to improve the channel from deep water to Montreal. This has resulted in a corresponding drop in the water level of Montreal harbor and the possibility of further dredging of the harbor itself. These factors, plus steadily increasing traffic and a continuing growth in the size of vessels using the St. Lawrence waterway, have created a serious problem for the future, Dr. Ince says.

The tidal model will be used to determine the influence of various changes in the river such as widening and deepening of the channel, building of breakwaters and dredging of shoals.

"We will try these changes on the model and then we can assess what effect they will have in nature," Dr. Ince says. "Will the water levels of the river be increased or decreased? What will happen to tide propagation? These are some of the influences engineers would like to know before undertaking marine construction work in the channel."

Dr. Ince says a model was necessary because the laws of fluid mechanics are not as easily understood as those of statics.

"There's quite a substantial area of uncertainty in this business. A designer can't sit in his office and come up with a finished design as he would for an office building. He needs to use experimental techniques and models for this work," Dr. Ince says.

The classic Canadian example cited to prove the worth of model studies is the construction in 1954 of the harbor at Port aux Basques in Newfoundland. This harbor was designed without model tests and it was found after construction that the ferry couldn't berth because the wave motion was more severe than anticipated.

"We were called in to undertake model tests to suggest a better layout for protection works and the wharves", Dr. Ince says. "The model study cost in the neighborhood of $60,000 and total construction costs were about $2,400,000.

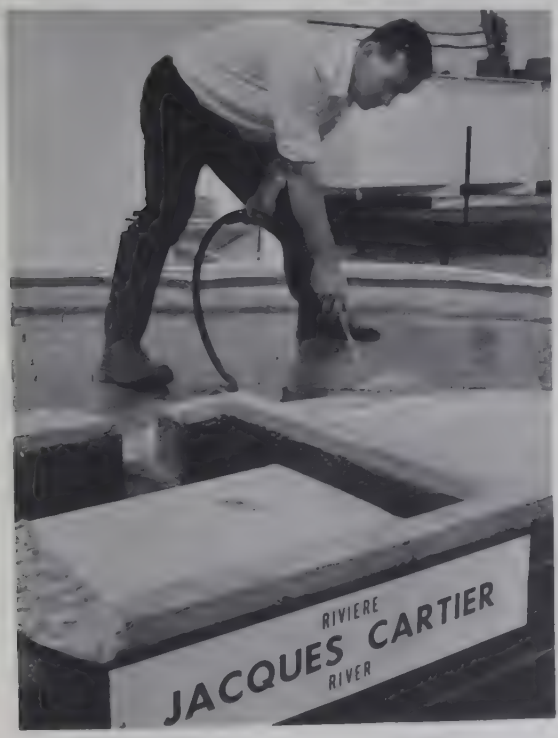
"When you're working with nature, $60,000 isn't too much to spend. Correction works in nature can easily cost millions. They are expensive, not only in terms of construction but in terms of tieups of traffic or of facilities."

Dr. Ince estimates the material cost of the St. Lawrence River model and its instrumentation and data processing and data control equipment at approximately $600,000. This doesn't include the effort in terms of manpower by the laboratory's engineers and technicians which he values at an additional $1,000,000 over a seven-year period.

This final cost figure is expected to be in the order of one per cent of actual construction and channel improvements costs. A rough rule-of-thumb holds that economic justification of a harbor or a river model is achieved when they cost between one and two per cent of the actual project, depending on its magnitude.

"Model studies may appear to be very costly but engineering experience shows that it pays many times over to do such studies," Dr. Ince said.

The model, supplied with water from a huge 500,000 gallon underground reservoir, is constructed of asphalt sides and has a moulded cement bottom based on hydrographic charts of the St. Lawrence. It has been constructed to a horizontal scale of 1:2,000 and a vertical scale of 1:120. In relation to the river, the model dimensions and slopes are distorted. To compensate for the resulting faster water flow rate, metal roughness strips are imbedded in the bottom at right angles to give additional resistance. A variety of current meters and water level recorders are used to take measurements in the model from the two input sources: river discharge at the Montreal end and tidal motion at the Father Point end.



Mr. Jordan hoses down section of model near mouth of Jacques Cartier river.

John Hutton and Francis Jordan working on a section of the river model in the Lake St. Peter area.

These instruments are first used to verify the model. Measuring stations ensure that water elevations and tidal motion in the model correspond in a direct ratio to those in the river channel. In this model, for example, the tide goes from low to high and back to low tide in four minutes. In the river, the tide cycle takes 12 hours and 25 minutes.

When a physical change is made in the model, data from these instruments are relayed to the Hydraulics Laboratory's "nerve centre" located in a mezzanine above the midpoint of the model. These data show the influence the change in the river channel has all along its length in terms of high water, low water and tidal motion.

In addition, data received are fed into large digital computers for use in a mathematical model which has been set up to double-check the findings of the tidal model. Once this is done the engineers are in a position to make a firm recommendation as to whether or not to go ahead with various proposed changes.

Dr. Andrew examines radio signal data recorded on tapes.

Radio Signal From X-ray Stars

Two radio astronomers at the National Research Council of Canada report the first detection of radio signals from recently-discovered X-ray stars.

Dr. B. H. Andrew and Dr. C. R. Purton of the Radio Astronomy Section of NRC's Radio and Electrical Engineering Division recorded radio signals at 4.5 centimetre wave length, from Scorpio X-1, strongest of the X-ray stars, with the Council's 150-foot diameter radio telescope. The telescope, one of the most powerful and versatile in the world, is located at NRC's Algonquin Radio Observatory at Lake Traverse in Algonquin Provincial Park, 120 miles northwest of Ottawa.

This initial discovery is important because measurements of the amount of energy emitted at X-ray and radio wavelengths are expected to give valuable clues as to what is going on inside the X-ray stars.

X-ray stars were discovered almost by accident six years ago when a group of scientists in the United States launched a rocket to look for X-rays from the moon. Instead, they found X-rays coming from the direction of the centre of the Galaxy. Since then, astronomers have discovered some 20 X-ray stars, the strongest being in the Scorpio constellation.

The reason X-ray stars were discovered only recently is attributed to the fact that X-rays cannot penetrate very deeply into the earth's atmosphere and therefore, their discovery had to await the development of rockets and satellites. Because X-ray astronomy has to be carried out from rockets and satellites, it is particularly difficult to pin down the exact positions of X-ray stars in the sky. Nevertheless they seem to be in the Milky Way, which means they are in the same galaxy as the sun.

Dr. Andrew at control console of radio telescope.

In observing the X-ray star in Scorpio, the NRC astronomers were dealing with very faint radio signals from outer space. They had to take special precautions to make sure that the signals they were measuring were from the star and not from background radio noise.

"When the star's position first became known two years ago, we tried to detect it but mucked up the attempt," Dr. Andrews says.

The second attempt began last September and was crowned with success after seven months of intermittent scanning and rescanning. "I guess we were first because we dug a littler harder than the others," Dr. Andrew said.

Stars so far identified with X-ray sources seem to be remnants of stars that have exploded some time in the past, the novae and supernovae as they are called. The Scorpio source measured by Dr. Andrew and Dr. Purton corresponds to a star too faint to be seen by the naked eye, but which through a telescope also appears to be an old exploding star.

The NRC radio wave detection is an important step in the study of Scorpio X-1 and the other X-ray stars. The presence of radio waves rules out a preliminary theory about the stars that was based solely on X-ray observation.

Electrons in a hot gas of ionized hydrogen were thought to emit the observed amount and type of X-rays. But this theory could not explain the detected radio waves.

The NRC findings suggested the radio signals are better explained by emissions from electrons moving at high velocities in the strong magnetic fields of the stars. This "synchrotron radiation" was first observed in man-made particle accelerators that whipped electrons around at speeds approaching that of light.

But Dr. Andrew said more recent observations of the star's infrared radiation by American astronomers has complicated the problem even more.

The latest interpretation, based on all the data so far, suggests the radio waves are arising from a hot gaseous region around the star; the X-rays are arising from an area nearer the star.

Exchange Program

Her Excellency Dora de Vasconcellos and Hon. Mitchell Sharp.

The Canadian and Brazilian governments have concluded an agreement for a program of exchanges within the scientific communities of the two countries.

Notes bringing the agreement into effect were exchanged Aug. 29, 1968, by Hon. Mitchell Sharp, Secretary of State for External Affairs, and the Brazilian Ambassador to Canada, Her Excellency Dora de Vasconcellos.

The agreement, the first such arrangement between Canada and a Latin American country, will be administered by the Brazilian Conselho Nacional de Pesquisas and its equivalent in Canada, the National Research Council of Canada.

About five scientists from each country will be selected each year to spend six months to a year doing research in the other country. The number may be increased as needs develop. Provision also has been made for shorter reciprocal visits to enable scientists to take part in conferences and seminars.

The agreement is effective for two years and may be renewed. NRC plans to initiate its first competition in the near future to select Canadians for the first exchange.

J. S. Dewar

Dr. Marshall Laird

P. R. Sandwell

An industrialist, a university professor and a consulting engineer have been appointed members of the National Research Council. They are industrialist J. S. Dewar, President and Director of Union Carbide Canada Limited, Toronto; Dr. Marshall Laird, Professor and Head of the Department of Biology, Memorial University, St. John's, Newfoundland, and consulting engineer P. R. Sandwell, President of Sandwell and Company Limited, and Sandwell International Inc., Vancouver.

The appointments are for three-year terms, expiring March 31, 1971.

The three new members fill vacancies caused by the death of one Council member and the expiration of the three-year terms of two others. Dr. Gleb Krotkov, R. Samuel McLaughlin Research Professor of Biology, Department of Biology, Queen's University, Kingston, died Jan. 29, 1968. The terms of appointment of Dr. L. H. Cragg, President of Mount Allison University, Sackville, N.B., and W. F. McLean, President of Canada Packers Limited, Toronto, expired March 31, 1968.

Délégué Général

Dr. Cook

The National Research Council of Canada has made an important move to improve the effectiveness of the Council in fulfilling its broad role of fostering scientific and industrial research in Canada.

Dr. W. G. Schneider, President of NRC, has announced the appointment of Dr. L. G. Cook, 54, to a newly-created senior Council position of Délégué Général for Policy and Planning.

Dr. Cook, who played a major role in the development of Canada's nuclear power program, will assist the Council in the formulation of long-range policies and plans, both for the research activities of the NRC Laboratories, and for the support and encouragement of research in universities and in industry.

Dr. Cook, who was with NRC and Atomic Energy of Canada Limited from 1944 to 1956, is leaving a senior position with the General Electric Research Laboratory, Schenectady, N.Y., to accept the new NRC post. He joined General Electric as a project analyst in 1956 and since 1959 has been Manager of GE's Project Analysis and Program Planning Sections.

Dr. Cook, who will be assisted by a small group of scientists, engineers and economists, will be responsible for detailed analyses of existing NRC projects and programs, taking into account both the scientific and economic aspects. Alternative programs and alternative approaches to current programs will also be examined.

These analyses, which will be carried out in close collaboration with the people involved in the programs and projects, will facilitate the task of identifying NRC priorities in terms of national needs. Such analyses will be of particular value in budget formulation, and in the allocation of resources to individual projects.

Special emphasis will be placed on the assessment of existing policies and programs for the advancement of industrial research.

Born in Paris, Ontario, Dr. Cook is a graduate in Physics and Chemistry of the University of Toronto. He received his Ph.D. from the University of Berlin in 1939 and did postgraduate work at Cavendish Laboratory, Cambridge, England, in 1938-39.

In February, 1940, Dr. Cook joined Aluminium Research Laboratories Limited in Montreal. He was appointed Physicist in their new research laboratory, Kingston, Ontario in 1942, a position he held until 1944 when he was seconded to the National Research Council of Canada Atomic Project in Montreal.

Dr. Cook joined the project as General Chemical Consultant on the design of NRX, the world's first high-power heavy water moderated nuclear reactor and helped develop the Plutonium and Uranium 233 extraction Processes used in the first Chalk River Plants.

In 1946 Dr. Cook was appointed head of Chemistry Research at the Atomic Energy Project, which in 1952 was separated from NRC and placed under Atomic Energy of Canada Limited. Dr. Cook was appointed Director of AECL's Chemistry and Metallurgy Division in 1954, and held that position until he joined General Electric in 1956.

Posted to London

Neil Angus Smith, 51, of Ottawa, has been appointed Scientific Liaison Officer in the London, England, office of NRC under NRC's Chief Scientific Liaison Officer W. L. Haney.
Mr. Smith, born and educated in Scotland, is a retired Commander of the Royal Canadian Navy. He succeeds R. J. Brearley, who served in this post for 22 years and now has returned to Ottawa.

Housing Study

House No. 1 — completed.

A study by the National Research Council of Canada shows that home construction costs, especially in large housing projects, could be reduced significantly if houses were built in accordance with acceptable standards rather than traditional practice. It also shows that site labor costs accounted for only 14 per cent of the selling price of one project home constructed during the study.

An investigation of the labor and materials required in the construction of two wood-frame houses was conducted over a two-year period by the Housing Section of NRC's Division of Building Research. The homes were built in the subdivision of Glen Cairn in the Ottawa area with the co-operation of Connelly Developments Limited.

A. T. Hansen, NRC Research Officer in charge of the study, says the on-site construction cost of the first three-bedroom wood frame bungalow was $10,586, made up of 24 per cent labor, 74 per cent materials and two per cent equipment rental. The selling price of this home was $18,000, meaning that the on-site cost represented about 59 per cent of the selling price.

The remaining 41 per cent of the selling price was made up of serviced land costs, profit, overhead and various financial charges. When related to the selling price, the component costs were 14 per cent for labor, 44 per cent for materials and one per cent for equipment rental.

"At one time it was common to assume that site labor accounted for 40 to 50 per cent of the total cost of construction", Mr. Hansen says.

"The fact that the total on-site building cost of this house represented less than 60 per cent of the final selling price also leads one to speculate whether the items responsible for the remainder of the cost might not be a useful area for some future study."

The second house was almost identical with the first, but incorporated changes in construction advanced by the Division of Building Research that offered a potential saving of nearly $400. The changes did not significantly affect the over-all quality or appearance of the house and all of them conformed to the requirements of the Residential Standards of the National Building Code.

"This study showed that the potential savings from any individual change were relatively small, but when these were totalled they amounted to about four per cent of the on-site cost," says Mr. Hansen. "To a builder constructing 125 houses a year, this would mean a potential saving of about $50,000."

Mr. Hansen says that although some of the construction changes that were made are applicable only to the builder who erected the two homes, many of them could have general application. All are examples of

House No. 2 — completed.

what may be looked for in an exercise to reduce construction costs.

No attempt was made in the study to determine the effects on costs of job organization or material handling techniques. It is quite conceivable that further savings could have been brought about through refinements in these areas.

The study was confined to the site activities. Items such as land cost, overhead, profit, finance charges and mortgage insurance were considered outside the scope of the study.

The potential savings offered by the construction changes were not fully realized in practice for several reasons. Due to a shortage of mortgage money the second house was the only house under construction in Glen Cairn when it was built. Tradesmen were not able to proceed in an orderly fashion from one house to another and develop a regular rhythm of work, as was the case in the first house. As a result, many unchanged operations in the second house required increased labor time.

In assessing the cost saving potential of the construction changes, all labor was placed at $3.50 an hour. Materials costs were based on 1965 prices and on unit prices supplied by the builder.

Some examples of construction changes used in the second home:

Six-mil polyethylene film used beneath the basement slab as a substitute for crushed rock saved $28 in materials.

Placing footings without forms saved almost $19 in labor in forming and stripping, not to mention the cost of wear and tear on the forms.

The use of four nails per shingle instead of six saved $4 in materials and $7 in labor.

Substituting spruce for pine in the basement stairs saved $14.

Using three-eighths inch oak instead of one-half oak flooring and using one-quarter poplar plywood beneath resilient flooring rather than three eighths inch Douglas fir saved $23 in materials for the flooring and $11 in underlay. In addition, $3 less labor was used to lay the thinner floor.

Reducing header joists from two inches by eight inches to one inch by eight saved about $7 in materials. Moving the supporting beam a few inches to one side enabled the use of more efficient lengths of joists. This saved about $12 worth of joist lumber. Four additional joists were saved in replanning the floor framing. Had the labor worked as efficiently as in the first house a labor saving of $31 should have been realized.

Quantity of framing lumber was reduced to 6,085 fbm from 6,779 fbm and the amount of gypsum was cut to 4,658 square feet from 4,917.

Ultrasound Pinpoints Wood Defect

A. Zuidhof of the Photogrammetric Section examines wood sample under test.

A method for detecting defects in wood through the use of high-frequency sound waves has been investigated by the National Research Council of Canada.

The work was conducted by Dr. David Makow of the Photogrammetric Research Section of NRC's Division of Applied Physics following an inquiry by MacMillan Bloedel Limited of Vancouver, B.C., the giant Canadian pulp, paper and lumber complex.

Defects in wood, such as knots, rot, shakes or pitch, impair the strength of wood and lower its value as building lumber. In many cases, and especially with thick lumber, it is difficult to detect defects of this kind by visual inspection.

Dr. Makow made an investigation into the use of pulsed ultrasound as a possible method for the detection of such defects. The ultrasound method was successful under controlled laboratory conditions. Considerable interest in the laboratory findings has been expressed by the industry in view of possible applications.

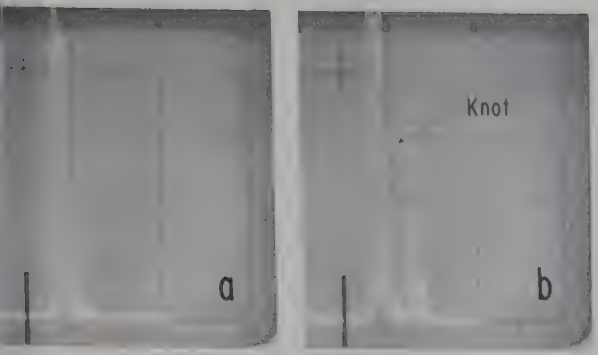
For example, an important application would be a method which could permit detection of defects in virgin timber as it is moved into the sawmill. If defects can be pinpointed rapidly, it should be possible to orient logs for the most economical cutting.

The equipment used for the experiments in the laboratory consisted of a small tank of water, an ultrasonic transducer, a transmitter and receiver and an oscilloscope used in previous projects. Samples of wood supplied by the lumber company which measured about eight inches by five inches by 1½ inches were placed on the foam-padded bottom of the tank.

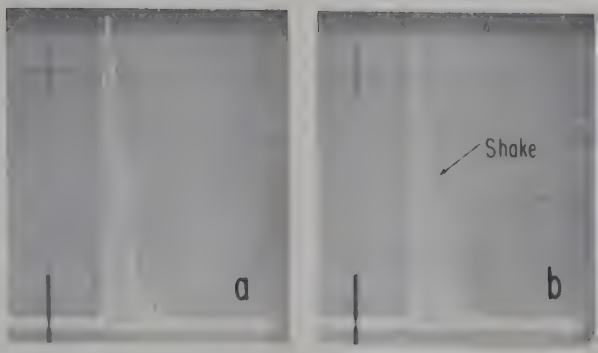
Ultrasound pulses from the ultrasonic transducer at a carrier frequency of one million Hertz (cycles per second) were transmitted through the water into various parts of the wood sample. Echoes reflected from interfaces inside the wood having dissimilar density and compressibility were returned to the transducer, amplified in the receiver and appeared on the oscilloscope as a trace.

The various defects found in wood differ considerably in their shape, composition and origin. During the tests, echo patterns on the oscilloscope pinpointed the presence of knots, rot, pitch and shakes. Shakes are cracks usually along the grain of the wood. Pinholes, which are small defects caused by insect larvae, were not detected at a frequency of one million cycles a second. However, it may be possible to detect them at higher frequencies.

The pattern of the ultrasound echoes will display common characteristics for one type of defect, but may differ considerably in its detailed structure from sample to sample. Detection of defects can be best accomplished by comparison with the echo pattern



Detection of a knot in a wood sample. A—Echo pattern away from the knot. The echoes are quickly absorbed and the far wood/water-soaked-foam interface echo is not displayed. B—Echo pattern from the knot. Because the knot does not absorb ultrasound as much as the surrounding wood, the far interface and subsequent echoes are clearly visible.



Detection of a shake filled with water, about ¾ of an inch below the surface. A—Echo pattern away from the shake. B—Echo pattern over the shake. Note the dip in the pattern and the subsequent echoes.

from the same piece of wood free of defects. Such a comparison is obtained by systematic scanning of the wood under examination.

Dr. Makow says the experiments showed that the characteristics of the echo patterns of wood containing defects are the following:

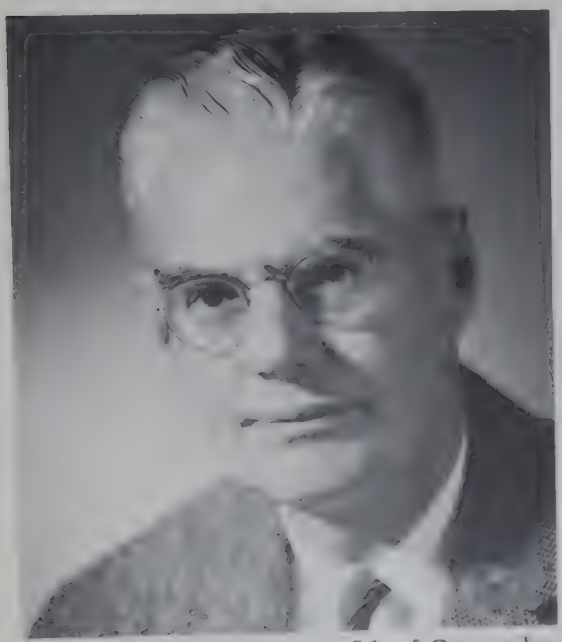
A defect which absorbs ultrasound less than the surrounding wood will permit the display of echoes from interfaces behind the defect which may be located at greater depths in wood as in the case of knots.

A defect of uniform composition shows up in the echo pattern as a region of small or of no echoes, as might be the case with rot filled with water.

A defect exposed at the surface or close to the surface affects the amplitude of the reflected echoes from the surface-water interface. This shows up as a sudden amplitude change of the echoes when scanning across the defect.

A defect filled with air may completely absorb echoes originating from structures behind this defect.

Executive Director



Dr. D. W. R. McKinley, 56, of Ottawa has been appointed Executive Director (Laboratories) of NRC.

Dr. McKinley, formerly Director of NRC's Radio and Electrical Engineering Division, will be responsible in his new position for the over-all operation of the NRC laboratories. Dr. McKinley's successor in the Radio and Electrical Engineering Division has not yet been appointed.

A Professional Engineer, Dr. McKinley is a graduate of the University of Toronto, where he received his B.A., M.A. and Ph.D. He joined NRC in November, 1938, and was appointed Assistant Director of the Radio and Electrical Engineering Division in 1954, Associate Director in 1960 and Director in 1963.

During the Second World War, Dr. McKinley supervised the development of long-range radar equipment. He received the O.B.E. for his wartime services. Since 1945, his researches have included a series of radio studies of meteors, which have appeared in 40 scientific papers and one book.

Dr. McKinley is a member of the Engineering Institute of Canada and a Fellow of the Royal Society of Canada, the American Physical Society and the Institute of Electrical and Electronics Engineers.

Mr. Kusters (left) and Mr. MacMartin test new potentiometer.

NRC Develo World's Best Potentiomete

A new type of potentiometer that is so accurate and stable that it cannot be calibrated against any known electrical measuring instrument has been developed by the National Research Council of Canada.

Potentiometers are high precision instruments for accurately measuring low direct current (DC) voltages. They are used by research laboratories, national standards agencies and industry to ensure that the voltages they are working with are as accurate as possible in terms of the National Voltage Standard.

Potentiometers make it possible for industries to relate their products to the National Voltage Standard with greater precision. This, in turn, permits the manufacture of products with an increased degree of accuracy.

The new potentiometer was developed by N. L. Kusters, Head of the Electrical Engineering Section of NRC's Radio and Electrical Engineering Division, and M.P. MacMartin, a member of Mr. Kusters' section. It is now being manufactured by Guildline Instruments Limited, Smiths Falls, Ont., under a licence granted by Canadian Patents and Development Limited, a subsidiary of NRC which has patented the new instrument.

An entirely new measuring principle has been incorporated in the new potentiometer, which Canadian Patents and Development Limited describes as the most accurate and stable potentiometer ever built.

The conventional potentiometer consists of a set of accurately known resistors and switches which make it possible for an output voltage to be produced which is a known fraction of a reference voltage. The output voltage is made equal to the voltage being measured. As a result of this arrangement no current flows between the output voltage and the voltage being measured when the two are connected.

The new potentiometer developed by Mr. Kusters and Mr. MacMartin is based on an NRC-developed DC Current Comparator, a device in which currents are compared in terms of their magnetic effects on a magnetic core. In the measurement of any DC voltages below two volts, it can be read to one tenth of a millionth of a volt (0.1 microvolt). "Drift" is negligible.

The most accurate conventional potentiometer on the market today was designed by Dr. T. M. Dauphinee, of the Heat and Solid State Physics Section of NRC's Division of Applied Physics. It can be read to one millionth of a volt, although because of "drift", it is accurate only to within three or four millionths of a volt.

This potentiometer also is manufactured by Guildline. During the last 10 years the

company has produced 250 units which have been sold mainly on the international market. Production of this potentiometer by Guildline helped this company to become internationally known as a Canadian producer of highly specialized measuring instruments, most of them developed by NRC scientists.

Guildline's success has been so great that the company has found it necessary to embark on a major expansion program. Work started in July on a plant addition which will more than double present floor space to 23,000 square feet from 10,000.

Jack Sutcliffe, President of Guildline, says "the expansion is made necessary by the world-wide success of new developments in the instrument field, brought about by the co-operation between the National Research Council and Guildline."

Despite its high degree of accuracy, the new instrument is cheaper and easier to manufacture and to use than conventional potentiometers. Instead of having to manufacture, adjust and shield dozens of resistance coils with extraordinary accuracy, the manufacturer has only to wind the right number of turns of wire around a magnetic core and to shield them properly.

The new potentiometer is one of two Guildline instruments which received awards in an international competition held to select the 100 most important technical developments in the field of electronic instrumentation and components. The competition is sponsored annually by Industrial Research, a prominent United States trade journal.

Mr. Sutcliffe says this was the first time that a Canadian firm had won an award in this competition. It was unusual, he said, for any company to have two entries accepted. The second instrument also was based on the Current Comparator developed by the Electrical Engineering Section.

Mr. Sutcliffe reports intense interest in the new potentiometer by measurement scientists. Normally, the company receives orders for new equipment only after it has been successfully demonstrated. However, in this case the demand for the revolutionary new potentiometer is so great that the company received many formal orders before its first prototype was built. The orders came from major national standards agencies including the Commonwealth Scientific and Industrial Research Organization in Australia, the United States National Bureau of Standards in Washington and the National Physical Laboratory in Teddington, England.

Mr. Sutcliffe (right) inspects work in progress in Guildline's plant addition.

Environment Greenhouse

Prototype of greenhouse on roof of university's Agriculture Building. Final installation will be in Biological Science Building in background.

The University of Alberta has received a grant of $400,000 from the National Research Council of Canada for construction of a unique research facility for the study of plants and animals native to Canada's northern areas.

The research facility, first of its kind in Canada, will be a Controlled Environment Greenhouse in which temperature, humidity and light can be controlled over long periods. It will be one of several controlled environment facilities to be built for the university's Department of Botany at a total cost in excess of $1,000,000. The other facilities include standard greenhouses, environmental growth chambers for teaching and research, and controlled facilities for seed germination and plant propagation.

The first instalment of the grant amounting to $350,000 is to be paid in the 1968-69 fiscal year. Subject to the availability of funds, the remaining $50,000 will be paid in 1969-70.

These facilities will be located in and upon a new Biological Science Building to be constructed on the university's Edmonton campus at an estimated cost of $20,000,000.

The 1,384-foot square Controlled Environment Laboratory will be the largest of the facilities and, in effect, will be a giant greenhouse in which the environment of northern areas, including that of the Arctic, can be simulated. The laboratory and some of the growth chambers will be used for long-term ecological and physiological studies of Arctic, boreal and alpine plants, and for animal experiments in the field of environmental physiology.

Although much of this research can be carried out using growth chambers and low temperature rooms, the construction of a Controlled Environmental Greenhouse will provide a facility with maximum radiation, equivalent to northern sunlight, in which temperatures can be kept constant, if required, as low as 50 degrees Fahrenheit.

The greenhouse will contain a number of rooms in which different northern and mountain environments can be simulated. This will permit a variety of experiments to be conducted simultaneously in different environments.

Few universities or research laboratories in Canada and the United States possess this kind of facility. One of the few comparable greenhouses in the world is located at the University of Copenhagen in Denmark.

The existence of these facilities will enable university scientists to study the effects of single and simultaneously varying environmental factors on particular organisms, populations and communities. It will be possible to undertake studies on growth rates and productivity of populations; tolerance, survival and adaptation of organisms; and interactions within communities, including such things as competition, commensalism and predation, with every prospect of obtaining exact data on specific questions. The results of these research activities should lead to significant advances in knowledge of the Arctic, boreal and alpine areas of Canada.

The Director of these new facilities is Professor Lawrence C. Bliss, plant ecologist in the Department of Botany.

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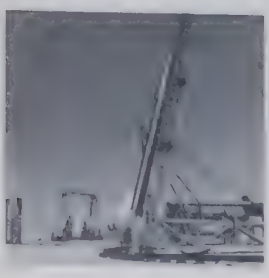

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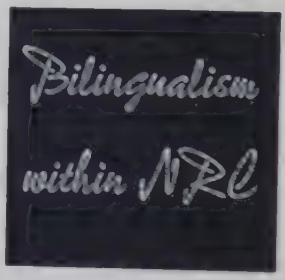


OPERATION SAPPORO

Skier Andy Dobrodzicki in crouch position in glassed-in test section of wind tunnel. G. A. Dobrodzicki (foreground) and Ski Team officials record reduction in drag achieved with streamlined helmet.

Tests conducted in Ottawa by the National Research Council of Canada and the Canadian Amateur Ski Association may give Canada's National Ski Team a split-second edge over competitors at the next Winter Olympics at Sapporo, Japan, in 1972.

Important and sometimes startling results were achieved in the tests which were conducted in a six- by nine-foot horizontal wind tunnel operated by NRC's National Aeronautical Establishment. Three skiers from the Ottawa area took part in the initial tests which are expected to be performed periodically for several years.

The objective of the tests, dubbed "Operation Sapporo", is to find ways to reduce drag or wind resistance experienced by skiers competing in downhill races. Any decrease in drag could result in a corresponding increase in a skier's speed.

The tests were proposed by Jean-Pierre Picher, of Toronto, Alpine Coach for the Southern Ontario Zone of the Canadian Amateur Ski Association. Others involved from the skiing world are Alan Raine, of Nelson, B.C., Administrative Head Coach for Canada's National Ski Team; Dave Jacobs, of Montreal, former Head Coach of the National Ski Team, and Normand Bureau, of Pointe Gatineau, Que., of the Pointe Gatineau Ski Zone.

The tests were conducted on a weekend by a team of engineers from NAE's Low Speed Aerodynamics Laboratory, who donated their time to the project. They included R. J. Templin, Head of the Laboratory; H. H. Kelland, Wind Tunnels Superintendent, and G. A. Dobrodzicki, a member of the Laboratory with considerable skiing experience. The skiers involved in the tests were Betsy Clifford, Susan Graves, and Andy Dobrodzicki, son of G. A. Dobrodzicki.

The wind tunnel simulated actual drag conditions experienced by skiers travelling up to 80 miles an hour in downhill races. Skiers who took part in the tests wore their own racing equipment and their skis were mounted on a board attached to the wind tunnel's system for measuring aerodynamic forces.

Simulated drag experienced by the skiers as wind generated by the tunnel's fans whipped by them at various speeds was recorded automatically by electronic equipment for later analysis. For the purposes of the tests speeds of up to 111 miles an hour were simulated. *(continued)*

Drag was measured for some 14 body positions, including the "egg" position, a crouch which has proved the fastest riding position for high-speed skiers. Drag created by a skier's helmet, slacks, boots and the skis themselves also was measured.

Mr. Raine says he thinks these tests have produced a new racing position, a crouch he calls the "DJR" position—named after G. A. Dobrodzicki, Mr. Jacobs and himself. He believes this position may shave as much as two seconds per minute from times achieved with the "egg" position.

Since only 9/100ths of a second separated the Gold and Silver Medals during the 1968 Olympics, the "DJR" position could be an important asset to the Canadian team in 1972.

Tests also were made with skiers wearing a streamlined helmet, fairings attached to the back of the leg and boot and with the buckles of the ski boot taped. These tests also indicated that changes in the design of ski equipment and clothing can reduce drag.

Mr. Raine said one of the most important results of the tests was the effect of the position of a skier's hands on his speed. A hand flailing out for a second or so, perhaps to steady balance, can increase drag and reduce speed.

The tests showed that each skier also had his own body position. Before Canada's National Ski Team left for Europe in December for international competition, all members were tested in the wind tunnel to determine their best body positions for maximum speed.

"The results of the tests will be made known only to the Canadian Amateur Ski Association," Mr. Templin said.

"We hope we can help members of the National Ski Team improve their time in downhill races," Mr. Kelland said.

Mr. Picher said in this day and age Olympic medals are being won by hundredths of a second.

"For instance, even with timings that precise, there was a tie for second place in the women's giant slalom in 1964, and the spread to first place was only a couple of hundredths of a second."

Fairing being attached to the ski boot of skier Andy Dobrodzicki.

Efforts now were being made to develop devices to get timing down to thousandths of a second. Anything that could give the Canadian team an advantage of such fractions of a second was worth looking into.

World Olympic skiing champion Nancy Greene said she was delighted to see the National Ski Team and NRC co-operating in a program to streamline ski racing equipment.

"I hope there can be the same type of co-operation in other areas of sport so that Canada can be original and not do just what everybody else is doing," she said. "I would like to see such bodies as the National Research Council involved in the design of other sports equipment which could help improve Canada's competitive position in sports."

Miss Greene said Canada cannot produce good pole vaulters because fibre glass poles are not manufactured in Canada and must be imported. These poles are very expensive and most schools cannot afford them.

"If a plastic pole could be designed and manufactured in Canada at a reasonable cost, we would be in a better position to produce pole vaulters. This is just one example of steps that could be taken to help Canada improve its position in amateur sport."

Dermatological Diagnosis

A National Research Council biochemist and two American doctors have shared an award from the American Academy of Dermatologists for pioneering work in dermatological diagnosis.

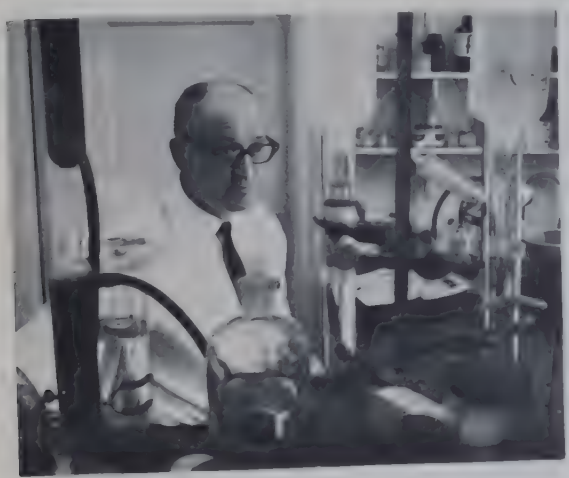
Dr. Claude T. Bishop, Assistant Director of NRC's Division of Biochemistry and Molecular Biology, has been collaborating over the last six years with Dr. Fritz Blank, a microbiologist, and Dr. Sarah Grappel, an immunologist, of the Philadelphia Skin and Cancer Hospital.

Together they have shown for the first time that the human body can develop antibodies to dermatophytes—moulds or fungi that cause diseases of the skin such as athlete's foot, ring worm and favus.

They achieved this with seven of 28 patients afflicted with various types of skin infections. Their findings—submitted to the Academy as an exhibit—were awarded the Bronze Award at the 1967 meeting of the Academy at Chicago.

According to Dr. Bishop, the significance of their preliminary work lies in the possibility that a new method of diagnosing the cause of skin infections may be at hand.

Because dermatophytes are completely resistant to antibiotics, no broad-band treatment is available. Rare cases are treated individually. Doctors scrape a specimen of the organism from its host, grow it in an artificial medium and examine it under a microscope.



Dr. Bishop with the equipment used in dermatological diagnosis.

"With these organisms, the cure is based on identification. Growing is difficult and microscopic identification is tricky. This makes it an area where misdiagnosis is possible—in which case you could spread rather than eliminate the disease," Dr. Bishop says.

He says he hopes the end product—years off at best—would be a simple test (similar to the tuberculin skin test) for the identification of all types of dermatitis.

The key to such a test is the polysaccharides. These complex sugars differ in each organism. They are identified through chemical separation.

The polysaccharides have been found capable of producing a reaction in blood serum taken from a subject injected or infected with the organism from which the polysaccharides were derived.

In the case of the 28 patients, the procedure was to identify the infecting organism in each case through conventional means. Polysaccharides were chemically separated. Then blood serum samples were taken and polysaccharide material added.

If the patient's body had produced antibodies as a defence against the infecting organism, there would be a characteristic reaction proclaiming, in effect, that there were antibodies present and that the organism was the infecting agent. This occurred in seven cases.

"We feel this is quite significant because it's a little surprising that a dermatophyte infection would cause antibodies. Because the infection is on the skin surface, it would appear unlikely these things could get into the bloodstream and into the lymph glands—the site of antibody production."

Dr. Bishop said the next step is to improve techniques to the point where they could prove useful in diagnosis. "If it can be conclusively established that humans do produce antibodies to these organisms, then a diagnostic skin test to cover all such infections becomes feasible."

Work is continuing with Dr. Blank and Dr. Grappel handling clinical tests and isolation and growing of organisms for production of polysaccharides in Philadelphia, while Dr. Bishop handles the chemical separation of the polysaccharides in his Ottawa laboratory.

New base for Volt/Ohm

The National Research Council of Canada announces that a new base of reference for the volt—the practical unit of electromotive force (emf) or voltage, became effective in Canada January 1, 1969. The base of reference for the ohm—the practical unit of electric resistance—was also modified on the same date to make it conform with the recognized international value.

"We have changed the values of the volt and ohm, as maintained in Canada, to agree more closely with the best knowledge of absolute values available today," says Dr. A. F. Dunn of the Electricity Section of NRC's Division of Applied Physics.

Canada's basic standards of physical measurement, including the volt and the ohm, are housed and serviced by the Division of Applied Physics. The Division acts as Canada's national standards laboratory and provides Canadian industry and science with the foundation for all their measurements.

The new base of reference for the volt is being adopted on an international basis and will bring the volt units of 10 countries (Australia, Canada, France, Germany (East), Germany (West), Italy, Japan, the Soviet Union, the United Kingdom, and the United States) into agreement. This action follows the adoption in Sèvres, France, in December by the International Committee on Weights and Measures of a recommendation of the Committee's Advisory Committee for Electricity.

At a meeting in Paris in October, 1946, the International Committee recommended a conversion from the international electrical units to the absolute system and this was universally adopted on January 1, 1948. It was agreed that one mean international volt equalled 1.000 34 absolute volts. The mean international volt was the average of the units maintained in France, Germany, Japan, the Soviet Union, the United Kingdom, and the United States, which took part in this work before the Second World War.

Experiments since 1948 by laboratories throughout the world have shown that the value of the volt, as maintained by groups of standard cells at NRC and other standards laboratories, can now be measured more accurately in terms of the absolute units. The new value represents a better measurement of the voltage of these cells in terms of the theoretical unit of electromotive force derived from the basic units of length (meter), mass (kilogram) and time (second).

With this reassessment, the value of the

S. J. Brunette operating the comparator for NRC's standard cells which define the volt.

volt as defined by the International Committee will be decreased by 11 parts in a million. For Canada the decrease will be eight parts in a million, because the existing value of the volt in this country is three parts in a million less than that currently defined by the International Committee.

The other national laboratories will change the value of their volt by varying amounts to make it conform with the new international standard. These laboratories, which now participate every three years in international comparisons of standard cells (which define the volt) and standard resistors (which define the ohm), will in future maintain units of voltage which are within one part in a million of each other.

The new value for the volt became effective January 1, 1969, in all 10 countries except Russia. The change will be made in Russia sometime during 1969.

The base of reference for the ohm has not been changed by the International Committee. However, Canada will increase its value of the ohm by three parts in a million to bring the Canadian standard into agreement with the absolute value recognized by the International Committee. Five other countries are taking similar action so that in the future all 10 countries will be maintaining units of resistance which are within one part in a million of each other.

The increasing importance of precision measurements has made it evident that a more accurate realization of the absolute volt and ohm is needed. A considerable portion of Canadian industry, especially companies manufacturing precision electrical equipment, must measure voltages and resistances to a few parts in a million.

Industries and others using standard cells and standard resistors send these standards to the Division of Applied Physics periodically to have them calibrated against the Division's basic standards. Starting January 1, these standards will be calibrated in terms of the new values, from which it will appear that standard cells are eight parts per million higher and standard resistors three parts per million lower in value. During 1969, at least, the old values will also be quoted on the calibration reports.

A major benefit of the changes is that Canadian industry no longer will have to consider the differences between countries in voltage and resistance values when producing compatible equipment. This will be especially true with respect to exports to the United States under the multi-million-dollar Canada-U.S. production sharing program, as well as the NATO contracts.

NRC's standard resistors which define the ohm. The resistors are immersed in a bath of oil.

Executive structure of NRC reorganized

Following the appointment in the Fall of 1967 of Dr. W. G. Schneider as President of the National Research Council of Canada, a series of meetings was held with the Executive Committee of the Council for the purpose of re-examining the effectiveness of the Executive Structure.

The Council agreed with Dr. Schneider that a more functional executive organization is necessary in view of the rapid growth of universities and the increasing emphasis being placed on the application of science to national problems. This necessitates better planning and co-ordination of research at the national level.

As a result of the decisions taken at the meetings, the Executive Structure has been reorganized to provide a more functional rearrangement of responsibilities.

The National Research Council of Canada, under the National Research Council Act, consists of the President, the Vice-President (Administration), two Vice-Presidents (Scientific) and not more than 17 other members appointed by the Governor in Council. The Council is a body corporate and is required to meet at least three times a year.

The Council is responsible to a designated minister who is a member of the Committee of the Privy Council on Scientific and Industrial Research. Hon. C. M. Drury, President of the Treasury Board, is the present Minister reporting to Parliament for the Council. Except for the four permanent officers, Council members are appointed for a term of three years and serve without salary. Council members are drawn from the senior staff of universities, industry and labor, with an attempt to achieve a broad base of advice, both as to scientific discipline and regional representation.

The new executive re-organization provides, in addition to the appointment of two new statutory Vice-Presidents, for two additional senior positions, and the establishment of five functional areas, three being the responsibility of the statutory Vice-Presidents and the others being the responsibility of the two new senior officers.

Another main reason for the reorganization and the creation of two new senior positions is that in reviewing the current executive organization it was apparent that, by attempting to keep Vice-Presidents informed in all areas, executive responsibilities of the Vice-President have become too diffuse and onerous, particularly with the growth of a number of areas of activity.

Accordingly it was considered necessary to institute a more functional organizational arrangement, with more senior positions, each with a narrower focus in terms of operational responsibility. This will give greater opportunity for generation and consideration of policy questions by the Executive.

Under the reorganization, the following appointments have been made:

Dr. L. G. Cook, Délégué-Général, responsible for Program Analysis and Review, Research Policies and Planning. He formerly was Manager of the Project Analysis and Program Planning Sections of the General Electric Research Laboratory at Schenectady, N.Y.

Dr. Cook will assist the President and the Council in the formulation of long-range policies and plans, both for the research activities of NRC Laboratories, and for the support and encouragement of research in universities and in industry. He will be assisted by a small group of scientists, engineers and economists and will be responsible for detailed analyses of existing NRC projects and programs, taking into account both the scientific and economic aspects. Alternative programs and alternative approaches to current programs will also be examined.

These analyses, which will be carried out in close collaboration with the people involved in the programs and projects, will facilitate the task of identifying NRC priorities in terms of national needs. Such analyses will be of particular value in the allocation of resources to individual projects, and in budget formulation. Special emphasis will be placed on the assessment of existing policies and programs for the advancement of industrial research.

Richard D. Hiscocks, Vice-President (Scientific), responsible for Industrial Research Assistance and Promotion. He formerly was Director of Research and Future Projects with deHavilland Aircraft of Canada Limited.

Mr. Hiscocks

Mr. Hiscocks, in collaboration with Dr. L. G. Cook, will develop and promote policies and will have administrative responsibility for all programs for industrial research assistance and promotion. This will include the development and promotion of closer contacts with industry and other applied research laboratories. He will have administrative responsibility for the Council's Industrial Research Assistance Program and the Technical Information Services.

All programs in this area will be co-ordinated with the Council's program of grants to universities and with work in NRC laboratories and other government agencies.

Dr. Donald J. LeRoy, Vice-President (Scientific), responsible for the Council's Awards Program for Support of University Research. He is Chairman of the Department of Chemistry and Head of the Graduate Department of the University of Toronto.

As Chairman of the Council's Standing Committee on Grants and Scholarships, Dr. LeRoy will be responsible for generating policies and programs in this area in collaboration with Dr. L. G. Cook. This will include close liaison with universities. He will have administrative responsibility for university grants and scholarships, inter-disciplinary Development Grants and grants for major university installations. He also will be responsible for the Council's Awards Office.

Dr. LeRoy

Dr. LeRoy's appointment is effective July 1, 1969. Until that time, the position will be filled on an acting basis by Dr. W. H. Cook, Executive Director of NRC.

Dr. D. W. R. McKinley, Executive Director (Laboratories), responsible for Intramural Laboratory Research Operations. Dr. McKinley formerly was Director of NRC's Radio and Electrical Engineering Division.

Dr. McKinley will be responsible, in consultation with Directors of NRC laboratories and Dr. L. G. Cook, for the development of policies and research programs essential to the Council's responsibilities. In co-operation with Directors of NRC Divisions, he will undertake periodic reviews of current NRC research programs and assess projected programs.

He will be responsible for the co-ordination and effectiveness of NRC research programs and for co-ordination and liaison of NRC research with industrial and university programs and those of other government agencies and departments.

Dr. K. F. Tupper, Vice-President (Administration), responsible for Administration. He formerly was Vice-President (Scientific) of NRC.

Dr. Tupper will be responsible for financial management, including estimates, budgets and accounts. He will also be responsible for personnel management and will have administrative responsibility for administration and research services.

Appointments and Honors

Dr. Claude T. Bishop, 43, has been appointed Assistant Director of the Division of Biochemistry and Molecular Biology of NRC.

Dr. Bishop, who joined NRC in 1949, is an Editor of the Canadian Journal of Chemistry. In his new position he will continue to conduct research in the fields of carbohydrate and immuno chemistry.

William A. Cumming, 42, has been appointed Director of the Radio and Electrical Engineering Division.

Mr. Cumming, Assistant Director of the Radio and Electrical Engineering Division since January, 1967, succeeds Dr. D. W. R. McKinley as Director. Dr. McKinley recently was appointed Executive Director (Laboratories) of NRC.

An electrical engineer, Mr. Cumming joined NRC in 1947.

Dr. Alexander E. Douglas, 51, has been appointed Director of the Division of Applied Physics.

He succeeds Dr. L. E. Howlett, who retired recently after 35 years of service with the Council.

Dr. Douglas also is Associate Director of the Division of Pure Physics, a post he will continue to hold. The Director of this Division is Dr. Gerhard Herzberg.

Dr. Neil B. Hutcheon, 57, has been appointed Associate Director of the Division of Building Research.

Dr. Hutcheon has been Assistant Director of the Division of Building Research since 1953. He will serve as Associate Director until later this year when he will become Director on the retirement of Dr. R. F. Legget.

Dr. Fred T. Lossing, 53, has been appointed Assistant Director of the Division of Pure Chemistry.

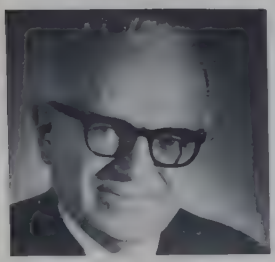
Dr. Lossing joined NRC in 1946. In his new position he will continue as Head of the Mass Spectrometry Section of the Division of Pure Chemistry.

René Montpetit, 45-year-old Montreal-born newspaperman and public relations officer, has been named NRC's Chief of Information Services.

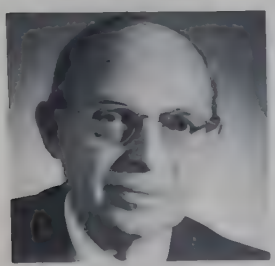
Mr. Montpetit will report directly to Dr. W. G. Schneider, President of NRC.

From 1966 until his appointment to the newly-created NRC position, Mr. Montpetit served as Assistant to the General Directorate, Regional Bureaux, Ministry of Education in Quebec City.

Dr. N. E. Gibbons, Assistant Director of NRC's Division of Biology, was elected President of the Board of Trustees of BioSciences Information Service of Biological Abstracts for 1969. Canadians have served on this board as Trustees, but this is the first time that a Canadian has been elected President.



Dr. Gerhard Herzberg, Director of NRC's Division of Pure Physics, was named a Companion of the Order of Canada. He also received an Honorary Doctor of Science Degree from Memorial University of Newfoundland. In October and November, Dr. Herzberg spent five weeks at Cornell University as George Fisher Baker Non-Resident Lecturer. The only previous Canadian lecturer in this series was the late Dr. E. W. R. Steacie, President of NRC from 1952 to 1962.



George J. Klein, Head of the Engineering Laboratory of NRC's Division of Mechanical Engineering, received an Honorary Doctor of Law Degree from Waterloo Lutheran University. The citation to the Degree states that Mr. Klein "works in the forefront of Canadian science and his contributions have won him world-wide acclaim."

Dr. William G. Schneider, President of the National Research Council of Canada, received an Honorary Doctor of Science Degree from Memorial University of Newfoundland. Dr. Schneider also spoke at the 1968 Tripartite Chemical Engineering Conference in Montreal on "A Nation Plans its Engineering Research."

Computer-aided teaching systems

A long-range program has been launched by the National Research Council of Canada to increase the productivity of Canada's educational process through the use of computer-aided teaching systems.

The extensive program, undertaken with the co-operation of educational bodies, industry and government, is being conducted by the Information Science Section of NRC's Radio and Electrical Engineering Division and is being directed by J. W. Brahan and W. C. Brown.

Mr. Brown, Head of the Section, says the educational facilities of most countries, including Canada, are being subjected to ever-increasing demands as automation spreads and daily life becomes more complex.

"Not only are the formal school systems being required to provide a higher level of education for an increasing number of students, but there is a growing requirement for retraining of workers as their jobs are made either obsolete or more complex by the introduction of automation," he says.

"Demands also are being made for increased adult-education facilities as a result of the increased leisure time available to the worker as his productivity increases. This all points to a shortage of competent teachers in the very near future and an increasing work-load for those already involved.

"Industry has made use of modern technology to increase industrial productivity. Application of the same kind of modern technology through use of the digital computer offers a means of increasing educational productivity to meet the growing demands on educational facilities."

Mr. Brown emphasizes that computer-aided teaching systems will not replace teachers but will relieve them of time-consuming routine tasks making it possible for them to give more attention to the problems of individual students. A carefully designed system can tailor lessons to the needs and the learning rate of the individual student, it can challenge the gifted, enrich the curriculum of the superior student, provide the more repetitious instruction needed by the slow learner and afford the special facilities

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HELLO
        PLEASE TYPE YOUR NAME.
JW BRAHAN
        WHICH COURSE WOULD YOU LIKE TO STUDY TODAY?
GEO1
        THIS UNIT CONCERNS FRUIT FARMING. A BOOKLET
       OF MATERIALS RELATED TO A TYPICAL NIAGARA
       PENINSULA FRUIT FARM HAS BEEN PROVIDED.
       AS YOU PROCEED, FOLLOW DIRECTIONS CLOSELY
       AND ANSWER ONLY AFTER CAREFUL CONSIDERATION.
       YOUR PURPOSE IS TO ACCURATELY VISUALIZE
       THE MANY ASPECTS OF FRUIT FARMING. ANSWERS
       SELDOM REQUIRE MORE THAN TWO WORDS.

        BEFORE PROCEEDING, SKIM THROUGH ALL MATERIALS
       PROVIDED.

        USING AN ATLAS, LOCATE GRIMSBY, ONTARIO.

        HAVE YOU LOCATED GRIMSBY?
NO
        PERHAPS THE FOLLOWING WILL HELP.
        A PLACE MAY BE LOCATED BY FINDING THE PLACE
       NAME IN THE INDEX OF THE ATLAS AND NOTING
       THE SYMBOLS WHICH FOLLOW THE PLACE NAME.
       FIND RENNES, FRANCE IN THE INDEX.

        WHAT ARE THE SYMBOLS (NUMBER, LETTER, AND
       NUMBER) FOLLOWING THE NAME?
30D3
        GOOD
        THE 30 REFERS TO THE PAGE ON WHICH YOU
       WILL FIND RENNES, AND THE D3 REFERS TO THE
       GRID SQUARE. CAN YOU NOW LOCATE RENNES?
       (YES OR NO)
YES
        WELL DONE.
        NOW, LOCATE GRIMSBY, ONT. STATE THE PAGE
       AND GRID NUMBER TO SHOW THAT YOU CAN.
16D3
        SUCCESS IS YOURS!
        TO WHAT DOES THE 16 REFER? (PAGE OR GRID
       SQUARE)
PAGE
        RIGHT
        TO WHAT DOES THE D3 REFER?
GRID SQUARE
        WELL DONE.
        THE INDEX SYMBOLS, THEN, TELL YOU WHERE
       TO FIND A PLACE NAME ON A MAP. ARE YOU NOW
       ABLE TO LOCATE GRIMSBY?
YES
        WELL DONE.
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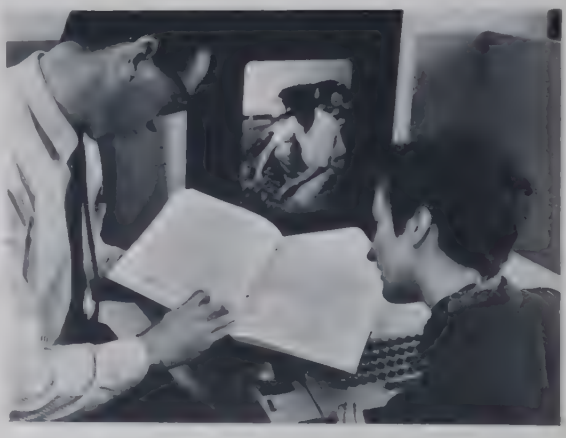
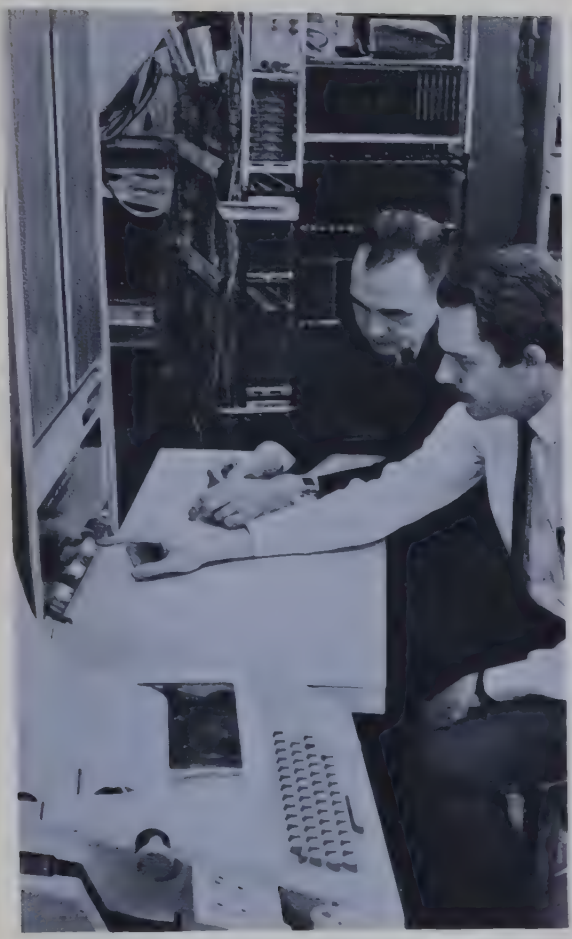
Above—printout from computer lesson. Below—John Humphries, engineer, and Martha Symonds, mathematician, at student terminal. Photograph on screen is a slide controlled by the computer to supplement material provided to student by computer on typewriter.





Mr. Brown (left) and Mr. Brahan at controls of small switching computer which permits information transfer to and from a number of student terminals over a single line to and from a central computer. Below—rear view of disc storage unit, experimental laboratory model.

needed for the disadvantaged and those confined through illness. Only a small percentage of a student's time will normally be occupied in this conversational computer mode; much of the learning period will be occupied with tutorials and discussion groups under the teacher's guidance.

A major advantage of such systems is that a computer is impersonal and impartial. Students are not subject to class ridicule if they give an incorrect answer and the computer can be programmed to provide statements in greater depth until a point is clearly understood and tested.

The NRC program is concerned with the problems involved in the application of the digital computer as an aid to teaching. It will include the assessment and subsequent development where necessary of input and output equipment, information storage and retrieval methods and the systems programming required to make computer-aided teaching effective at all educational levels.

"It should be clearly understood", Mr. Brown says, "that our plans include no work on curriculum content—that is strictly a matter for the educational authorities. Likewise the evaluation of the system as it evolves will be under the direction of competent educators."

Efforts will be concentrated on the development of terminal equipment and of specialized computer facilities such as random access audio and video storage and on the writing of control programs. The aim is to provide a system which effectively communicates with the student and which can be used easily by the teacher in preparing instructional programs and in monitoring and updating their presentation. Natural language commands permit the teacher to communicate easily with the system.

Mr. Brown says the research program will require the active participation of industry and educators if success is to be achieved. Initial discussions of co-operative projects with industry, government and educational bodies have been encouraging and committees are being set up to assist in the guidance of such work in Canada.

NRC studies Icing Problems

A joint research program has been launched by the National Research Council of Canada and the Department of Transport to devise methods to counteract dangerous icing of small ships and to improve current ice removal procedures.

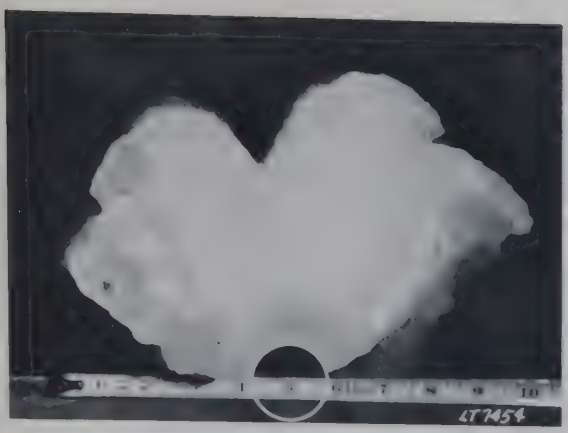
The work has been undertaken mainly because of serious icing problems caused by the cold Labrador current which flows southward past the coast of Newfoundland, producing sub-zero air temperatures. Sea spray blown over small vessels, especially fishing trawlers, can cause heavy icing of superstructures and riggings.

The onset of this type of icing can be quick and treacherous. Crews often are unable to cope with ice buildup by conventional means—knocking it off by laborious use of hammers, mallets or axes. A number of ships have capsized under the weight of ice, with all hands lost.

The icing research project is being conducted by the Low Temperature Laboratory of NRC's Division of Mechanical Engineering. Initial tests have been made in an icing wind tunnel on the formation and growth of ice on cylinders of various diameters.

Tests in the United Kingdom on a model fishing trawler in an icing wind tunnel were mainly concerned with loss of stability due to ice accretion. The NRC tests are concerned with the more basic aspects of the icing process itself. As such, they form a useful introduction to some of the concepts of icing technology.

Iced up trawler puts into east coast port.



A cross section of ice formed in icing tunnel on a 1½-inch diameter cylinder in one hour at a temperature of minus 15 degrees Centigrade, with a water concentration of 3.2 grams per cubic metre of air and with a wind velocity of 50 miles an hour.

A side view of ice formed on a 12-inch diameter cylinder in one hour at a temperature of minus 11 degrees Centigrade. Water concentration and wind velocity were the same as in the test with the 1½-inch cylinder.

The icing tests were conducted in a closed circuit, refrigerated icing wind tunnel in which the air is continuously recirculated by a 1,000 horsepower electric fan. At one point in its circuit the air passes through a cooling heat exchanger to maintain it at a desired temperature. The icing condition is produced by an array of water spray nozzles located ahead of the 4½-foot square test section. The tunnel produces air speeds of up to 190 miles an hour and the temperature ranges from room temperature to minus 30 degrees Centigrade.

Five cylinders measuring 1½ inches, three inches, six inches, 12 inches and 18 inches in diameter were used to determine the effect of air temperature and cylinder diameter on the percentage of spray that freezes on the cylinder. Tests were run on each cylinder in both a horizontal and a vertical orientation. The air speed was set at 50 miles an hour, corresponding to a fresh gale on the Beaufort Scale, and the air temperature ranged between minus 16 degrees Centigrade and minus five degrees. The icing sprays were set to give a water concentration of 3.2 grams per cubic metre of air, with the water droplets averaging about 1.5 millimetres in diameter.

"The tests constituted a rather tentative introduction to the subject of superstructure icing resulting from sea spray," says J. R. Stallabrass, engineer in charge of the project.

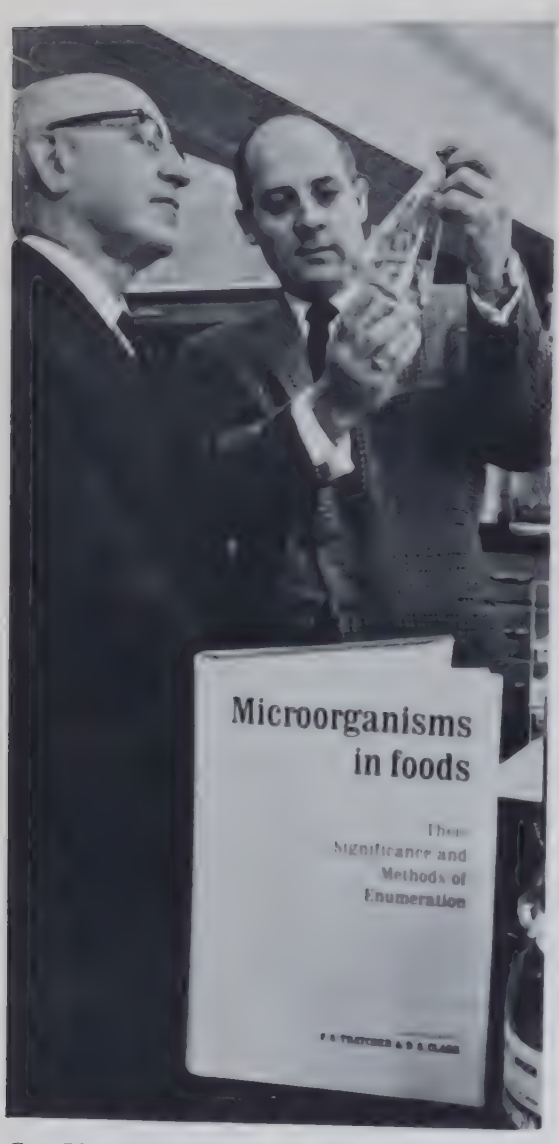
No very definite information is currently available regarding the characteristics of sea spray, including water content and drop size distribution. Not only are these difficult to measure but they are a function of a large number of other factors such as state of the sea, wind force and ship speed and heading relative to the wind. The water concentration and drop size used in the tests were chosen rather intuitively within the capabilities of the existing spray-producing facility of the icing wind tunnel and are felt to represent conditions that might exist under various actual sea conditions.

Mr. Stallabrass says results of the tests provide a useful guide to the fraction of water that actually freezes on riggings, rails, spars, masts, etc. over an extended period of time.

The tests showed that the efficiency of ice buildup increases with decreasing cylinder diameter. For small diameter cylinders the ice width may grow to many times the cylinder diameter.

"The tests indicate clearly the absolute necessity for reducing riggings, rails, spars, masts, stays, etc. to a minimum as one very necessary measure for diminishing the hazard of icing at sea," Mr. Stallabrass says. "Where it is not possible to dispense with them completely, one larger diameter strut should be made to do the job of several smaller ones."

Scientists fight
FOOD POISONING



Dr. Thatcher (left) and Dr. Clark examine a microbial culture in a flask. Their new book on table in foreground.

Two Canadian scientists are spearheading an international campaign to prevent the spread of diseases through bacteriologically contaminated foodstuffs.

Dr. F. S. Thatcher, Chief, Division of Microbiology, Food and Drug Directorate, Department of National Health and Welfare, and Dr. D. S. Clark of the Food Technology Section of the National Research Council's Division of Biology are, respectively, the chairman and secretary of the International Committee on Microbiological Specifications for Foods, a standing committee of the International Association of Microbiological Societies.

The Committee—composed of 20 leading microbiologists from government, university and industrial laboratories in 11 countries—has spent four years compiling data on microbiological methods for determining food-poisoning and indicator organisms in factory-processed foods. Meetings have been held in Montreal, Cambridge, Moscow and London.

In December, the University of Toronto Press published the results of their deliberations under the title "Microorganisms in Foods: Their Significance and Methods of Enumeration".

Dr. Clark says the purpose of the book, which will prove invaluable to all concerned with the microbiological content of foods, whether in government control agencies, industry, teaching or research institutions, is to describe in detail test methods judged effective for the various categories of food poisoning microorganisms—together with an appraisal of the significance of these organisms in foods.

"A major part of our work to date has been to select the best methods available for the determination and enumeration of bacteria such as salmonellae and shigellae, which multiply in the intestinal tract causing disease through infection of the host, others such as staphylococci and *Clostridium botulinum* whose toxins, present in food at the time of consumption, are direct causes of illnesses, and of certain bacteria, although themselves harmless, which indicate the possible presence of pathogens in foods."

"Later we hope our program of international inter-laboratory testing will enable us to go one step further and eventually recommend one method for each category of bacteria. It is our hope that these 'tried and proven' methods will be accepted internationally particularly for food moving in international commerce. This is prerequisite to the formulation of standards of acceptability for foods both nationally and internationally. A common basis of judgment would avoid many contemporary problems in the safe movement of foods."

A first step towards this goal has already been taken. Dr. Thatcher has organized a comparative testing programme involving 39 government and university laboratories from many countries. The first test relates to salmonellae but all important categories of foodborne bacteria will eventually be involved. Samples are sent out from the Food and Drug Directorate to these laboratories for testing under specified procedures. Results are to be returned to Ottawa for analysis.

Dr. Clark says the rapid increase in international trade in foodstuffs, rapidly growing diversity of microbiological methods for examining foods, the hazards created each time new techniques of mass production are developed, and introduction into trade of foods from areas where certain diseases are residual has made surveillance very necessary. Salmonellosis, for one, is now considered a serious health problem.

"We are convinced that the work of the Committee, particularly this testing exercise, will not only be extremely useful to those countries with a well-developed food control system, but will be invaluable to many technologically developing countries and to interested agencies such as the World Health Organization who are helping continuously in such technical development. To promote more bacteriological testing and to extend the influence of the Committee—which is essentially a 'working party'—sub-committees are being formed in various parts of the world. One such sub-committee is already active in Latin America and another is being organized in the Balkan countries."

Identification of salmonella species derived from foods.

Rockets to probe Sun's 1970 Eclipse

Temporary launch site will be built near the tip of Smith's Point.

Canadian scientists will launch a series of high-altitude sounding rockets from a temporary launching site on the southeast coast of Nova Scotia during the 1970 total eclipse of the sun.

This will be the first time that sounding rockets have been fired into the upper atmosphere from a launch site in eastern Canada. All other rockets for upper atmosphere research have been launched from the National Research Council's Churchill Research Range at Churchill, Manitoba, from Cold Lake, Alberta, and from a site at Resolute on Cornwallis Island in the Canadian Arctic.

The eclipse of the sun, which will occur during the early afternoon of March 7, 1970, will travel along the east coast of Nova Scotia, across Cape Breton Island and on to Newfoundland. The path of totality will be about 75 miles wide and will cover approximately half of the province and extend well out to sea.

Scientists from the National Research Council and the Defence Research Telecommunications Establishment will fire four Canadian-built Black Brant III rockets into the upper atmosphere prior to and during the eclipse. The rockets will carry scientific instruments to an altitude of 100 miles to measure changes that occur in the ionization of the upper atmosphere when the sun's radiation is cut off by the moon.

The rockets will be fired in a southerly direction from a launch site on Smith's Point in the Quoddy Inlet area and will impact 45 miles out to sea. Measurements recorded by the instruments will be radioed to a ground receiving and recording station at the launching site.

The first rocket will be fired six minutes before the moon starts to pass in front of the sun. Its instruments will measure the undisturbed daytime ionization to provide a basis for comparison with measurements taken by instruments on the other three rockets.

The remaining rockets will be fired about one hour later when the sun is more than 80 per cent obscured by the moon. This is the period during which the maximum rate of change of ionization is believed to occur in the upper atmosphere.

These three rockets will be fired at six minute intervals starting just before the sun is totally obscured and ending after the sun starts to reappear. The period during which the sun will be totally obscured by the moon is two minutes and 20 seconds.

Information obtained from the rocket-borne instruments will be augmented by radio wave propagation measurements taken from ground stations. One of these will be at the launching site and others at the Defence Research Telecommunications Establishment in Ottawa.

The reason that the launch site will be located in the Port Dufferin area is that it is on about the same parallel of latitude as Ottawa and this will make it possible to correlate the measurements taken in the two areas.

Preparation of the site will commence during the summer of 1969. This will include the installation of telephone and power lines to the launch area, the pouring of concrete pads for the rocket launchers and the construction of a few temporary buildings for rocket preparation, instrument check-out, radio telemetry reception and launch control.

All arrangements for the launchings are being made by NRC's Space Research Facilities Branch.

BILINGUALISM WITHIN NRC

The National Research Council of Canada has instituted a plan for the posting of senior scientific staff to French-language institutions.

On the recommendation of a Director of a Division and with the approval of Council, members of the scientific staff may spend periods of from six months to a year at a French-language university or research institution, preferably in the province of Quebec.

Under this arrangement the scientist would use the period to pursue work of interest to him, but would in addition devote a substantial portion of his time to studies of the French language and culture.

The plan is expected to apply mainly to younger persons of great potential at the level of Senior or Principal Research Officer who have demonstrated a significant interest in and ability for training in the French language. Those posted will receive full salary, as well as travel and relocation allowances.

It is expected that the number posted in any one year would be small and that an effort would be made to distribute the postings among the various divisions of the Council. Approval of any posting would depend on the working out of arrangements suited to the individual case.

French-speaking university professors and other research workers are also to be encouraged to spend periods in the Council's divisional laboratories.

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On the Cover

Ottawa skier Betsy Clifford in wind tunnel for tests with ski clothing and equipment currently used by the National Ski Team.

NRC RESEARCH NEWS

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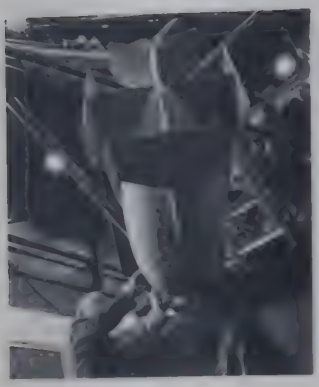

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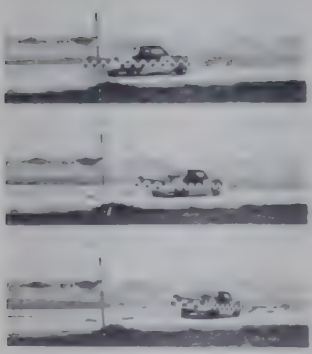

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new method for hydrographic surveying

Quicker exploitation of the mineral riches of Canada's Polar Continental Shelf is in prospect as the result of the development by marine engineers of the National Research Council of Canada of a new high-speed method for hydrographic surveying in ice-infested waters.

An air cushion vehicle carrying a retractable strut-mounted depth sensing system was successful in initial trials on Lake Erie in December.

The new method was born from the marriage of an ACV to a towed body hydrographic sounding system. It features a pneumatic-hydraulic lifting-lowering system permitting the towed body to be raised when the ACV is travelling over land or across ice.

On its first trial, clear and accurate depth recordings were made at speeds in excess of 25 miles per hour. Later runs attained speeds above 30 miles per hour.

The strut system's co-designers, S. T. Matthews, Head of the Ship Laboratory of the Division of Mechanical Engineering, and L. I. Kawerninski, an engineer with the section, in collaboration with E. S. Moore and N. L. Goddard of the Central Design Office, have guaranteed a speed capability of 40 miles per hour to the Hydrographic Section of the Polar Continental Shelf Project.

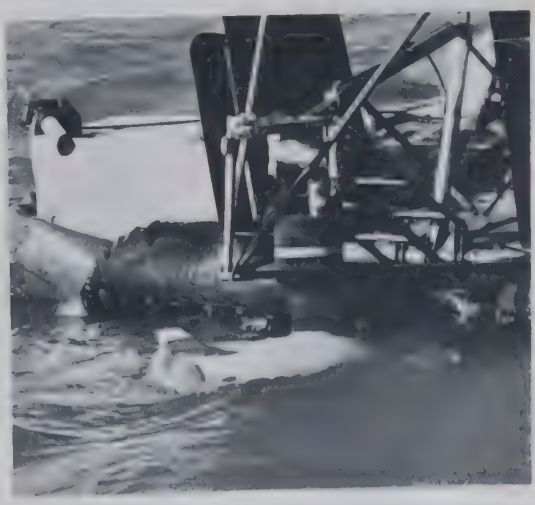
PCSP, which commissioned NRC to investigate the potentialities of ACV's for Arctic hydrographic operations, is a special study group set up 10 years ago by the Federal Department of Energy, Mines and Resources. It exists to gather data on the physical aspects of the northern continental shelf which extends 200 miles into the Arctic ocean.

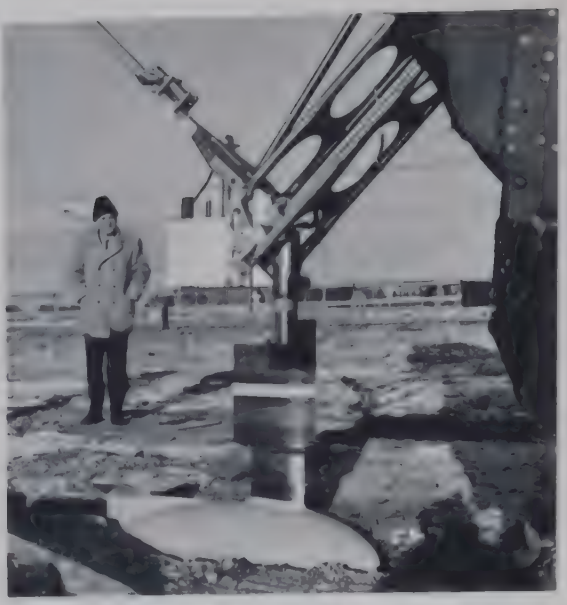
This summer PCSP begins work on the Beafort Sea above the northern coasts of Alaska and the Yukon. An area containing 10,000 linear miles of continuous profile soundings will be charted over the next three years. More miles will be added, according to George Yeaton, Senior Hydrographer with PCSP's Hydrographics Section, if the NRC fixed strut system proves out.

In the Arctic, PCSP hydrographers have been relying mainly on the helicopter to perform soundings through the ice on a spot-to-spot grid basis. In 1962 they began using towed body systems in order to see if they could speed operations by the continuous profile methods of hydrographic sounding.

In 1966-67, the Ship Laboratory and PCSP carried out tests first with a helicopter, then with a high speed launch and later with a Canadian Navy hydrofoil, to evaluate two sizes of fibreglass towed bodies

Towed body with lifting-lowering mechanism attached to stern of air cushion vehicle (left). (Right) air cushion vehicle in the water with towed body (foreground) partly submerged.





Air cushion vehicle crewman directs operations as ACV, mounted on mechanized steel carrying frame, is brought from hangar (left). Trench is used when testing the lifting-lowering mechanism (right).

designed by NRC in an earlier project with the Canadian Navy.

Each cable-towed body system has an echo sounder housed in a hydrodynamically streamlined body. Each body or "fish" is towed under water by a cable from either a surface vessel or helicopter. The fish must be in contact with the water in order to beam sound pulses downward and record their returning echoes.

These tests showed clearly that near-surface-towed systems have limitations. When a body is towed near the surface by a loose cable, a phenomenon known as aereation limits the speed at which recordings can be taken to below 25 miles per hour. Above this speed air bubbles travel down the cable to the fish. The noise generated by the collapse of these bubbles blanks out the echo sounder.

In the NRC fixed strut system, the fish rides just below the surface of the water at the end of a vertical faired strut. (One of the features of the fish is that it is self-tracking. It follows the horizontal angular motion of the hovercraft.) A pair of air fences encircling the strut spreads descending air bubbles and prevents aereation.

On the strut there is a built-in-vertical pneumatic spring made of laminated fibreglass. Air from a compressed air tank is fed into the spring making it softer or stiffer so as to counter the up-and-down motion created by high waves. This helps keep the fish at a more true distance below the surface of the water and helps protect it from excessive forces.

Compressed air is also used in the hydraulic-pneumatic mechanism to raise the body through eight feet for land and ice clearance.

Another feature used on the trials was a closed circuit television unit which permitted the hydrographer to watch the fish's performance in the water and simultaneously observe depth recordings being charted. This enabled the cause of performance irregularities to be swiftly spotted. A speed measuring instrument was also installed in the body for the trials.

The fish itself measures four foot six inches in length and has an 18 inch diameter. Mr. Matthews expects many other oceanographic measurements such as surface temperatures, salinity, etc., can be made simultaneous with depth soundings since the echo sounder takes up only a small portion of space available in the fish.

new library service for scanning titles

A computerized system for scanning the titles of papers published in selected journals and providing scientists and engineers at regular intervals with bibliographies of papers in their specific fields of interest has been developed as a joint project by the National Science Library and the Computation Centre of the National Research Council of Canada.

The system, after three years of experimentation and testing, will permit Canada's scientific, engineering and industrial communities to have quick access to the world's scientific information. Known as a mechanized system for the dissemination of information (SDI), it is the outgrowth of a broader program in which computers and related electronic data processing equipment are being used for the processing, storage and retrieval of information.

The SDI program at present is based on two magnetic tape services — Chemical Titles on tape produced by Chemical Abstracts Service, Columbus, Ohio, and ISI tapes produced by the Institute for Scientific Information in Philadelphia. The CT tapes, which have been used by the Library for more than two years, are supplied every two weeks and cover approximately 650 journals in chemistry and chemical engineering. Use of the ISI tapes was begun early in 1968. These tapes are provided weekly and cover 1,831 journals in many fields of science and technology. The two services account for about 600,000 title references annually.

The key to the SDI program is the preparation of interest profiles. For example, if a scientist or engineer is interested in the use of computers in teaching, his profile will contain key words such as computer, instruct, education, learning, teaching, CAI, CBI, CAL. The Library feeds this information into a computer, matching the key words to the titles of papers discussing computers and education, and recording the titles for users of the service.

The Library now provides 170 scientists and engineers with weekly bibliographies in their specific fields of interest. The service is solely one of current awareness and alerts scientists to the existence of new papers. The system does permit retrospective searches but this aspect of the program will not be practical until magnetic tapes have accumulated for several years.

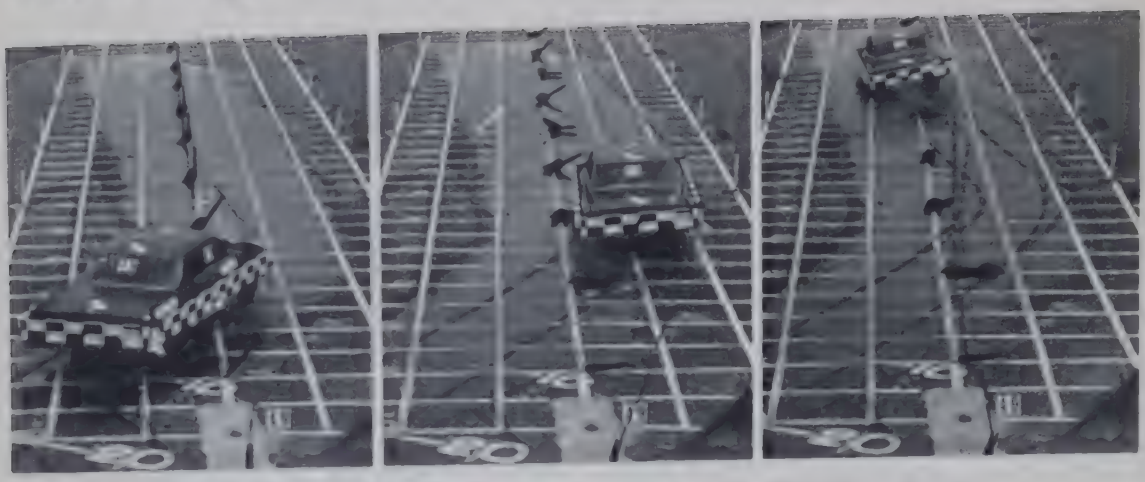
Until recently, restrictions by producers on the use of magnetic tapes and the experimental nature of the work, forced the Library to limit the SDI service to NRC scientists and other scientists in the Ottawa area. However, restrictions on the use of tapes have been lifted, the service has passed the experimental stage, and the Library now is planning to make the service available on a national scale.

Cost studies indicate that at present the service cannot be provided for less than an annual fee of $100 for up to 60 search terms. After an initial four-month period for profile adjustment there will be an additional charge of $1.00 per term for the maximum number of terms in excess of the 60 which occurred during the remaining eight months of the subscription year. In return a subscriber will receive each week, or twice a month, depending on the source tape searched, a list of papers based on his interest profile selected from the 2,481 journals covered by the CT and ISI magnetic tapes.

The Library also will supply photocopies or loan copies of cited papers which are not available in the subscriber's area. The charge for photocopies is 10 cents a page with a minimum charge of 50 cents.

Miss Suzanne Poirier using a key punch machine to prepare input data for the SDI project.

highway safety study



Series of photographs showing test car crashing into "soft" highway barrier.

Engineers at the National Research Council of Canada have undertaken a motor vehicle safety barrier investigation in an effort to improve the design of non-rigid or "soft" highway safety barriers.

Sixty-one times to date, project engineers with the Structures Laboratory of NRC's National Aeronautical Establishment have given a signal sending a remote-controlled automobile smashing into a "soft" highway safety barrier at speeds ranging from 18 to 51 miles per hour.

The objective of the "crash" program, still in its initial stage, is to make the first systematic study of non-rigid highway barriers, similar to the cedar post and steel cable variety found along most curves and embankments of Canadian highways.

If the program is successful, this work will lead to the design of a barrier that will reduce death or injuries due to barrier penetration or vehicle bounce-back into traffic, and minimize damage to vehicles and injury to occupants due to impact and interaction with the barrier.

The barrier study is being directed by G. F. W. McCaffrey, Project Engineer with the Structures Laboratory, and A. H. Hall, Head of the Laboratory. Dr. H. F. L. Pinkney, a dynamics expert in the Laboratory, is in charge of the computer program for the project.

"Our ultimate purpose is to design a barrier to save lives and cut down injury," says Mr. McCaffrey. "A lot of barriers now in use will do little of either."

Towards this goal, Structures Laboratory engineers moved onto an unused portion of a runway at Ottawa's Rockcliffe Airport last August. They erected a 250-foot barrier made up of a pair of ¾-inch steel cables carried in a slot atop 30-inch high steel posts, designed to fracture at ground level impacts above a certain force.

A 1963 sedan, chosen because it typified the cars now using Canadian highways, was "hardened" by the addition of a wrap-around steel bumper to withstand major structural damage during barrier impact. One reason for hardening the vehicles was to cut costs by using the same vehicle in many crash tests. Another was to achieve the minimum uncontrolled variability in the experimental vehicle from one test to another.

Load-measuring devices attached to the barrier cables, accelerometers mounted on the vehicle and high speed cameras on the ground and aloft were used to observe the dynamics of collision. On two occasions a helicopter was used to give additional photographic details.

Fifty-seven times, the first vehicle, known affectionately as "Force de Frappe Mark I", was push-started in second gear and sent screeching along a steel guide rail into the test barrier. The final four runs of the fall test program were made with an unhardened 1960 sedan since consigned to the scrap-heap. In all cases, the vehicle entered the

barrier at an angle of 25 degrees. This is deemed to be the maximum angle a vehicle could hit a typical parallel roadside barrier while travelling at normal highway speed.

Information from these and future tests will be assimilated by a computer which will solve mathematical equations. These solutions will then allow additional tests of the interaction of cars and different types of roadside barriers to be carried out inside the computer.

The computer is needed because many of the factors of design will have to be varied many times to find the best compromise among many possible solutions. For example, a barrier suitable for arresting a 70,000-pound truck would be just like hitting a brick wall for a small car.

Mr. McCaffrey expects through computer simulation to eventually develop a completely new barrier, acceptable on economic and engineering grounds as well as a human safety basis.

"But it is shaping up as a lengthy program", Mr. McCaffrey says. "Without considering any other type of barrier, the Laboratory could easily be involved in two to three years work. Currently, we are attempting to find out enough information so as to be able to predict with confidence what this particular barrier will do in a particular vehicle impact situation."

The Structures Laboratory group is still evaluating the results of last fall's test program while preparing to go ahead with a new test series.

Standing in the wings is "Sierra Stan". Stan is a commercially-manufactured dummy instrumented to measure acceleration on certain body areas, specifically the head, chest, pelvis and thighs. Designed for auto vehicle crash studies, he has working joints which can be adjusted to simulate muscular action, such as might occur in a crash. He also comes equipped with an articulated spine, to better simulate motion of a human body under impact.

"We will put Stan behind the wheel when we are satisfied we can run a predictable crash," Mr. Hall says. "By the end of two to three more months of testing and working on the computer program, we will probably have him helping us find out vehicle-barrier crash effects on auto passengers."

Currently the group is working on "Force de Frappe Mark I" (undamaged despite its 57 crashes), measuring such things as springing characteristics, exact centre of gravity, rolling rate and pitching rate. This type of information has to be available for the computer program and can be best done while winter forces a halt to track testing.

Mr. McCaffrey demonstrates how "Sierra Stan" will be used in future tests.

The story of rapeseed

Rapeseed is the fastest-growing seed crop in Canada. This position is due in no small part to the pioneer and continuing research by scientists at the Prairie Regional Laboratory of the National Research Council of Canada.

In 1939, when the Prairie Regional Laboratory — known initially as the Oil Seeds Laboratory — was established at Saskatoon, Sask., rapeseed was an unknown crop on the prairies.

Today, approximately 1,500,000 acres of prairie farmland is being sown to rapeseed annually. In the 1966-67 crop year, 25,800,000 bushels of rapeseed was harvested, yielding a farm value of $63,000,000.

In Canada, basic research information on composition, biochemistry, enzymology and analytical procedures was produced at the PRL. This information was used, in collaboration with other organizations in the scientific community (government, university and private industry), to solve the practical problems involved in making Canada the world's largest exporter of rapeseed.

Currently, this country produces about six per cent of the world's rapeseed. Approximately 25 per cent of the vegetable oil used in domestic margarines, shortenings and salad oils now comes from rapeseed. The value of exports of rapeseed is about equal to the value of vegetable-oil imports, thus making Canada essentially self-sufficient in vegetable-oil production.

Rapeseed first appeared in Canada in 1942, three years after Dr. R. Newton, then Director of NRC's Division of Applied Biology, transferred Dr. H. R. Sallans and Mr. G. D. Sinclair of his division, to Saskatoon and established the Oil Seeds Laboratory. The aim of the Laboratory was to foster development of oil seeds as a wartime source of industrial lubricants.

Rapeseed had a hurried wartime introduction when this search was begun to find a new source of marine engine oils. Dr. Sallans, now the director of the PRL, shared responsibility for initial testing for oil content and iodine value to ensure that rape oil would meet British Admiralty specifications.

Today, in the processing of rapeseed, 40 per cent of the yield is in the form of oil, 50 per cent in the form of oil meal, and 10 per cent as water waste. Initially, the oil was considered fit only for industrial uses, and the meal was best used as fertilizer because it was considered toxic.

After the war, the lack of an edible oil crop in Canada, the pressure of wheat surpluses, and very limited markets for industrial oils of the rapeseed type led to a program of research, undertaken at PRL, to develop rapeseed as a source of edible oil.

This work involved co-operation with plant breeders to improve seed quality, with animal and human nutritionists to clarify nutritional aspects, and with commercial crushers and formulators to improve processing and quality of product.

The first requirement was to produce a variety that would mature early and uniformly under Canadian growing conditions and that would have high oil content and satisfactory oil composition. Tests were conducted by the Canada Department of Agriculture; the analytical work was done by PRL.

As a result, breeding stocks with desirable characteristics were built up and, in 1954, Golden, the first variety tailored for growth in Western Canada, was licensed for distribution.

Golden was the first in a whole series of new varieties of rapeseed. The Canadian objective was rapeseed that would ultimately yield oils capable of competing on world markets, on a quality basis, with soybean, cottonseed, peanut, olive, sunflower and other vegetable oils. At the same time, investigators were looking at rapeseed meal in an effort to improve its quality for use as a livestock feed supplement.

One of the first obstacles in the development of rapeseed as a commercial oil crop was posed by the Federal Food and Drug Directorate. It had definite reservations on the use of oils containing erucic acid in human diets. This was based on the fact that erucic acid is not a normal constituent of animal body fats and reports in the literature suggested that it could have deleterious physiological effects. Since rapeseed was well adapted to growth in Canada a project to develop varieties free of erucic acid was undertaken.

In 1950, Dr. B. M. Craig of the Fats and Oils Laboratory of PRL became involved in determining the fatty acid composition of rapeseed oils for the information of plant breeders. At that time, two pounds of oil and two weeks of work were needed for each oil analysis.

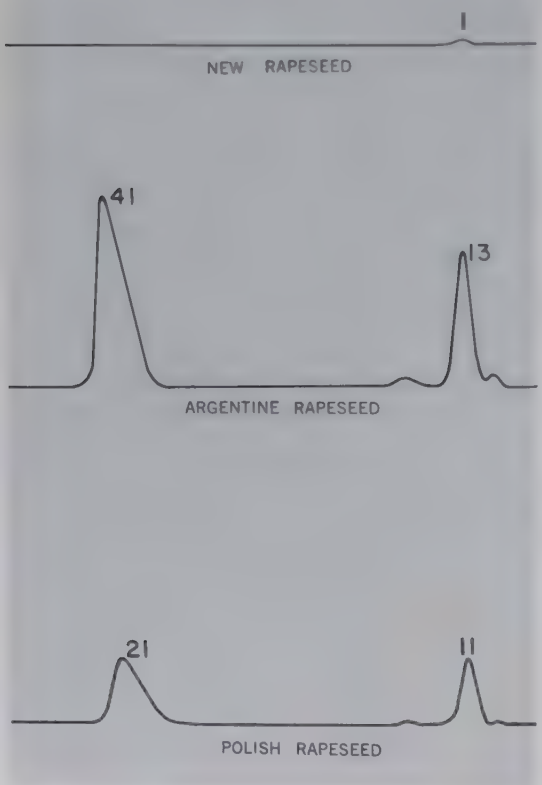
Dr. Craig in 1957 developed a butanediol succinate polyester for use in the quantitative analysis of rapeseed oils by gas liquid chromatography. This polyester now is available commercially and is known as the "Craig" polyester.

During the next few years, Dr. Craig continued to refine and improve gas liquid chromatography techniques for analysing rapeseed oil, and by 1962, it was possible to analyse samples of 0.5 to 1.0 milligrams of oil in 45 minutes. This made possible the "single seed technique" for plant selection, worked out in collaboration with Dr. R. K. Downey of CDA. This technique involved the analysis of the oil from one half of a rapeseed and the production of a rapeseed plant from the other half.

In 1963, this technique was used to analyse 700 single rapeseeds, from which six seeds were selected that contained no erucic acid. From these six seeds Dr. Downey produced a rapeseed variety which contained zero erucic acid and in 1968, 500,000 bushels of this new strain was grown under contact.

In 1964, oil extracted at PRL from 100 pounds of zero erucic acid rapeseed provided by Dr. Downey was submitted to the Canada Packers Research Laboratory, Toronto, for commercial evaluation. The investigation showed that this oil offered advantages in the production of salad oils. Partial hydrogenation followed by winterization gave yields of over 90 per cent as contrasted to 75 per cent from soybean oil. This new rapeseed oil was given the name CANBRA oil to distinguish it from erucic containing oils. The name CANBRA was derived from the first letters of the words Canadian and Brassica to designate the Canadian development of the new oil from a member of the Brassica family.

From left—Drs. Craig, Youngs, Wetter and Sallans study gas liquid chromatographic analyses of rapeseed oils. Charts show the fatty acid composition of representative samples of rapeseed oil produced in Canada and that of the new zero erucic rapeseed oil—CANBRA. Polish rapeseed oil has 21 per cent erucic acid, Argentine 41 per cent, and zero for CANBRA. Charts also show that CANBRA contains one per cent eicosenoic acid, while Polish contains 11 per cent and Argentine 13 per cent.



(Winterization involves chilling the oil to solidify fats which are removed by filtration, producing a clear oil. The yield advantage of CANBRA in the production of salad oils is thus due to the initial low level of saturated or solid fat).

During the 1962-63 period Dr. Craig undertook nutrition studies on rapeseed oil containing erucic acid in co-operation with the Food and Drug Directorate of the Department of National Health and Welfare and with Canada Packers, Toronto. These studies indicated that it was the low percentage of saturated fatty acids in the rapeseed oil rather than the presence of erucic acid which caused the growth reduction which occurred when experimental animals were fed rapeseed oil. When diets adequate in saturated acids were prepared at PRL and fed to animals by nutritionists in Ottawa, it was found that rapeseed oil containing erucic acid had no deleterious effects on nutrition.

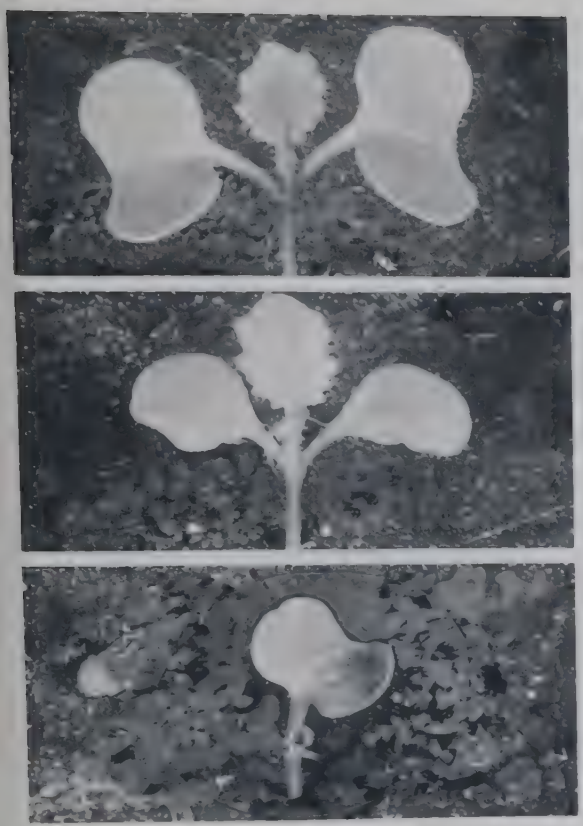
Further nutritional studies carried out in co-operation with the Food and Drug Laboratory in 1967-68 proved that erucic acid is metabolized in the rat by partial degradation to oleic acid. Since oleic acid is a major constituent of olive oil and all animal fats it was obvious that there was no basic nutritional problem with erucic acid as such.

As a result of this work rapeseed oil with or without erucic acid was cleared for use in human food products in Canada. Further nutritional tests showed that the CANBRA oil is equal to many other edible oils in nutritional quality.

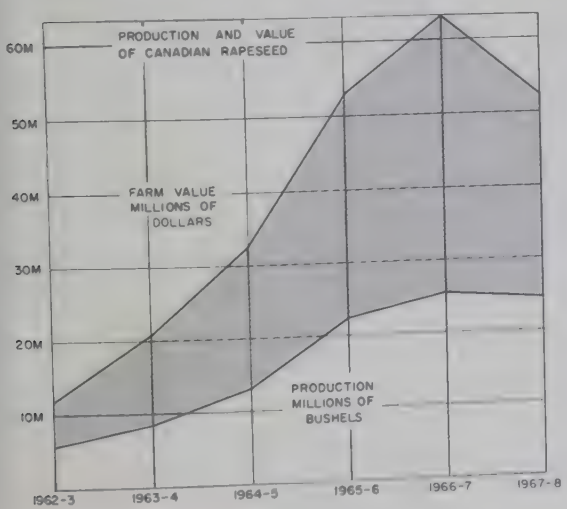
PRL, CDA, the University of Saskatchewan and the University of Alberta, also are conducting an extensive research program into the production of rapeseed meal for livestock.

When rapeseed meal was first fed to swine and poultry, there was a poor growth performance when large amounts were fed. It was felt that thioglucosides (sulphur compounds known to have goiterogenic effects) were partly to blame.

To test this hypothesis, reliable assays of these components were required. Dr. L. R. Wetter, head of the Plant Biochemistry Section of PRL, developed two methods



Stages of halfseed technique illustrated by normal rapeseed plant with two cotyledons and leaf beginnings (top); plant from dissected rapeseed with half of each cotyledon removed in the seed for analysis of fatty acid composition (centre); and plant with one cotyledon removed for oil analysis (bottom).



to assay rapeseed samples and to correlate toxicity with the content of thioglucosides. These two methods, with some modifications, have been used throughout the world for assaying rapeseed meal.

In 1962, Dr. C. G. Youngs, of the Engineering and Process Development Section of PRL, undertook a study to establish desirable conditions for the cooking of rapeseed prior to extraction in commercial plants. These conditions improved the quality of meal for livestock feeding, and are now used everywhere in the world where rapeseed is processed.

Recently Dr. Youngs, together with Dr. Wetter, has modified and developed an assay method that will provide plant breeders with a rapid and accurate means of qualitatively and quantitatively detecting toxic factors in the seed that would be retained in the feed meal to affect livestock.

This method is currently being used by CDA's Dr. Downey in an important breeding program in which he is attempting to select varieties that will have very low or zero thioglucoside content.

Some of these new lines are sufficiently advanced to permit nutritional tests. In this work CDA produces seed samples, PRL does analytical work and produces meal samples under conditions that would prevail in commercial processing plants, and feeding trials are done on mice and rats at the University of Saskatchewan and on chickens and turkeys by CDA at Swift Current, Sask.

Dr. Sallans feels this program has now reached the stage where extensive effort on development will yield new varieties from which the meal will be more valuable in feeding swine and poultry.

"This should expand markets for the meal in Canada and Japan. Japan is our best customer for rapeseed. However, most rapeseed meal in Japan is used as a fertilizer. When it becomes accepted for animal feeds in their poultry and swine industry the value of the product should be enhanced and the market expanded. Currently the meal in Canada sells at a discount of approximately $10 per ton protein basis on account of nutritional problems."

fast-dry systems

Canadian Patents and Development Limited is gambling $100,000 that a Toronto engineering firm can take a National Research Council of Canada invention and turn it into a major industry.

The crown corporation, whose responsibility it is to licence for commercial exploitation the inventions of government scientists, has given Devtek Limited the right to manufacture a family of microwave drying systems developed by the Antenna Engineering Section of NRC's Radio and Electrical Engineering Division. The co-inventors are W. J. Bleackley, a member of the Section, and W. A. Cumming, Head of the Section and also Director of the Radio and Electrical Engineering Division.

CPDL has backed up its choice of licencee with $100,000 in development contracts for industrial research and marketing of microwave dryers capable of extracting unwanted water from everything from glue to leather to plastic sheeting for films.

"We believe that, today, the NRC is pre-eminent in the field of microwave dry technology. And we feel that by aidi Devtek at the initial stage of industrial d velopment, we are fostering the developme of a new area of industrial competence f Canada," a CPDL official explains.

In a microwave dryer system, a microwa generator transmits microwaves through waveguide into a chamber which is designe to produce an intense electrical field. Jus as some materials are transparent to ligh waves, some materials are transparent t microwaves and, in the same way that ligh is absorbed when passing through wate or a thick piece of glass, microwaves ar absorbed when passing through some ma terials. Materials which readily absorb microwaves are called "lossy".

When microwaves are passed through lossy materials such as moist leather o water-base glue the water molecules within the material attempt to take up a particular alignment with the direction of the electrical field and hence oscillate around their axes

Mr. Bleackley, L. R. Horning, Manager, Corporate Engineering, R. L. Crain Limited, Ottawa, and Mr. Cumming with microwave drying unit installed as part of multi-part business form collating equipment.

in response to the rapidly changing field. This oscillation produces heat through intermolecular friction. Water molecules turn to steam and the material is dried as this steam evaporates.

Mr. Bleackley, and Mr. Cumming, through NRC, hold patents on inventions covering three different types of units using microwaves for high speed drying. One of these, the edgeline glue dryer, is designed for use as part of the production process for business forms. The prototype was developed in co-operation with R. L. Crain Limited, Ottawa.

This dryer promises to be a major source of sales by Devtek since it is able to dry multi-part business form bindings faster than existing collating equipment can assemble and glue-bind them.

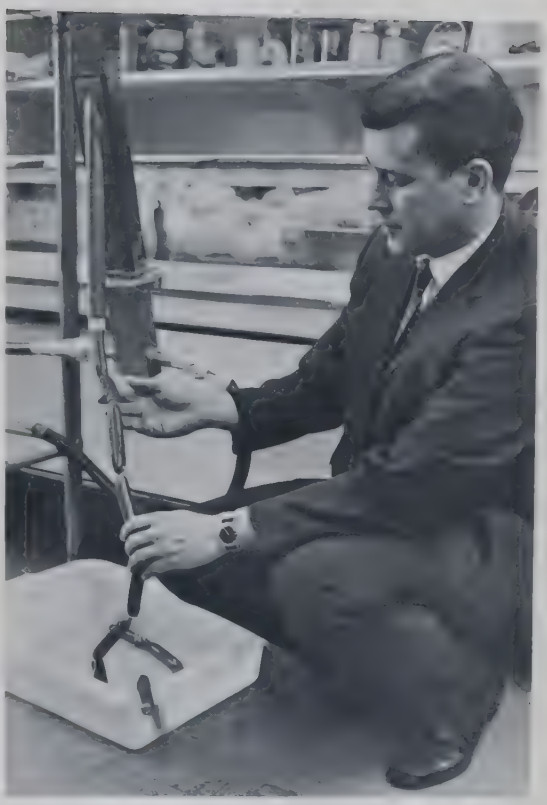
A unit, recently installed in the Toronto branch plant of the giant Moore Business Forms Corp., dries the glue on eight-part business forms at a rate of 600 feet per minute. The best conventional dryer operates at a maximum speed of 100 feet per minute. With this new development, drying no longer limits the speed of the business form collating process.

Devtek has also installed units in business form manufacturing plants in New York, Chicago, Montreal, Ottawa and Wichita, Kansas.

Devtek's Executive Vice-President Kenneth Fraser expects his company will gross $500,000 this year on sales of 40 edgeline dryers selling for $13,500 each. "We've been in touch with every major business form manufacturer in North America and we're very optimistic about the future," he says.

Other sources of sales are expected to come from a second type of microwave drying chamber known as a parallel plate region. This is designed to dry sheet material such as film, paper, plastics and leather. It is especially suited for drying continuously-fed material.

One unit has been installed in the British-American Bank Note Company plant in Ottawa. They want to evaluate microwave drying of glue on airmail envelopes. Preliminary tests have yielded encouraging results and success here could open up



Dr. Tape examines cooked weiners emerging from teflon tube in multiple ridge waveguide.

a wide field of gluebacked sheet stock to microwave drying, Mr. Bleackley says.

A similar unit is being installed at Standard Register Corporation of Dayton, Ohio, in order to evaluate it for use in gluedrying paper pockets onto paper sheets.

Another unit is going into a E. I. Dupont Nemours plant in Rochester, N.Y. Dupont will be evaluating its use with a type of photographic film.

Mr. Bleackley has hopes that the parallel plate region will also prove to be capable of drying cereals moving along a conveyor belt. He plans to experiment along these lines with Dr. N. W. Tape of the Canada Department of Agriculture's Food Research Institute in Ottawa.

Dr. Tape and he are currently experimenting with weiners using a third type of microwave chamber. This one is a "multiple ridge waveguide." It provides a uniform field over the cross-section of a

weiner. Weiners inserted into a teflon tube, pass through the chamber and emerge cooked and ready for packaging. The unit would replace giant ovens now used for cooking weiners during processing.

"We eventually expect to modify this unit for the types of foods that need quick drying for greater efficiency of production —spaghetti, liquorice, sausages, cereals—," Mr. Bleackley says.

Devtek's interest in microwave drying dates back three years to the day when Mr. Fraser saw an article in the Canadian Journal of Photography dealing with a microwave photographic print dryer developed by Mr. Bleackley.

Mr. Bleackley had previously been approached by the National Film Board of Canada with the suggestion that microwaves could provide high speed drying of large black-and-white prints needed in great quantity for Expo 67.

He designed a microwave print dryer that reduced time to dry a three-foot-square print to five minutes from 12 hours or more.

At that time Mr. Fraser's company had developed a film processor system and was looking for a more efficient method of drying the emulsion on photographic film.

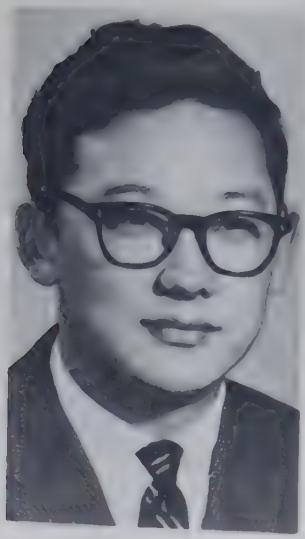
He contacted Mr. Bleackley about the possibility of using microwaves to dry film, a possibility then considered dubious in th light of a study by a leading U.S. industri microwave firm which claimed it to b technologically impossible.

Conversation led to collaboration an a microwave dryer for photographic fil emerged. It is deemed particularly suite for use in aerial photography and nego tiations are under way for its commercia development.

Collaboration continues today with Mr Bleackley acting as a technical adviser o microwave technology for CPDL and fo the Federal Department of Industry.

At the request of the Department of In dustry he worked with Devtek on a more conventional microwave chamber installed at a major Ontario shoe manufacturing plant. This unit is being evaluated for use in the bonding by glue-drying of the various pieces of leather that go to make up the upper part of a shoe.

He has also been called in as a technical consultant by the Department to work with another Devtek unit installed in the Collis Leather Company plant at Aurora, Ontario. Leather for shoes and handbags is subjected to up to seven coats of dye before the item can be marketed. Each coat must be dried. The microwave unit is being evaluated to determine its economic worth in this area.



Dr. David Suzuki, 32 (left) Department of Zoology, University of British Columbia, has been awarded the E. W. R. Steacie Memorial Fellowship for 1969 by the National Research Council of Canada. He is the fifth recipient of the Fellowship which was established by NRC in 1963, to perpetuate the name of the late Dr. E. W. R. Steacie, President of NRC from 1952 to 1962. The Fellowship is designed to give outstanding young staff members of Canadian universities an opportunity to spend two or three years in uninterrupted research.

Dr. H. J. Greenwood, 37, (right) Department of Geology, University of British Columbia, has been awarded the Steacie Prize for 1968 for outstanding work in petrology. The Prize, consisting of a cash award of $1500, is awarded annually by the Trustees of the E. W. R. Steacie Memorial Fund for distinguished contributions to one of the natural sciences by a younger person.

tenderness control

Often wonder why some chickens are tender and others tough?

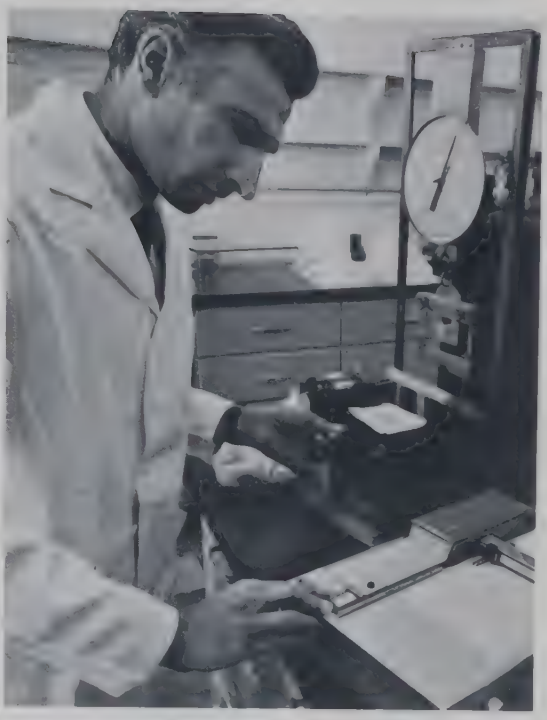
After two years of extensive tests, biochemists at the National Research Council of Canada think they have found one reason for this. They also believe that they have found at least part of a cure which could be implemented without increasing processing costs.

Tough poultry and meat represent a perpetual source of friction between consumers and retailers in the food industry. Present methods of quality control do not make possible easy identification of tough chickens and turkeys and tough cuts of meat. As a result, there is no way to prevent tough poultry and meat from getting in among fully tender meat.

Tests with chickens by the Food Technology Section of NRC's Division of Biology have shown that the treatment of birds before and during slaughter can make a bird tough. Dr. A. W. Khan, a member of the Section, says that treatments resulting in stress or excessive muscular activity just before or during slaughter are the cause of many a chewy bird.

During stress and muscular activity the body produces lactic acid, which in turn reduces the pH (a measure of acidity) of the meat. This process is known as glycolysis. If much lactic acid is produced during death, the pH drops below a critical value, irreversible changes take place in the muscle, and toughness results.

The pH of the living muscle is neutral at a value of 7. The pH of muscle after death eventually should drop to below 6 as acidity increases. It is essential, however, that the pH remain above 6.2 until the animal is dead and has stopped muscular activity. If it drops below 6.2 during the actual killing process, the meat will be less tender than it should be.



Dr. A. W. Khan takes measurements to determine tenderness of chicken meat samples.

The key to tenderness control is therefore prevention of stress and muscular activity just before or during death of well fed and well rested birds. This means more humane slaughtering methods, with only small changes in present-day practice and with no increased processing costs. Careful handling before slaughter and restriction of free movement of wings and legs during slaughter are essential.

Results may well be applicable to beef. To find out, Dr. Khan is continuing his studies with beef. If successful, the artificial tenderizers may not be as necessary as at present, and the meat buying chore of the housewife may be an easier one.

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